

COMMONWEALTH OF VIRGINIA
Department of Environmental Quality

Intra-Agency Memorandum

DATE: DRAFT January 24, 2014

SUBJECT: Engineering Evaluation of Prevention of Significant Deterioration Permit Application Submitted by Carmeuse Lime & Stone for its Winchester Facility (Registration No. 80504)

TO: Amy T. Owens, Director, Valley Regional Office

FROM: Kevin Covington, Air Permit Writer Senior, Valley Regional Office

AIR PERMIT MANAGER REVIEW: _____

DEPUTY REGIONAL DIRECTOR REVIEW: _____

I. Executive Summary

The O-N Minerals (Chemstone) Company, d/b/a Carmeuse Lime & Stone (“Carmeuse”), has proposed to replace the existing rotary lime kiln at its limestone quarry, limestone processing, and lime manufacturing facility located in Clear Brook (Frederick County) with two new state of the art, fuel efficient vertical lime kilns. Carmeuse refers to this facility as the “Winchester facility” (it is located about 6 miles northeast of the City of Winchester), so the Virginia Department of Environmental Quality (DEQ) does as well for consistency. The existing facility is an existing major source under 9 VAC 5 Chapter 80, and Prevention of Significant Deterioration (PSD) permitting is triggered for the proposed kiln replacement due to significant net emission increases in the following pollutants: nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO₂), total particulate matter (PM), particulate matter having an aerodynamic diameter equal to or less than ten micrograms (PM-10), particulate matter having an aerodynamic diameter equal to or less than 2.5 micrograms (PM-2.5), and greenhouse gases (GHG). Although emitted by the proposed new kilns, PSD permitting is not triggered for volatile organic compounds (VOC) or sulfuric acid mist (H₂SO₄ or SAM).

The following table shows the distances between the facility and all Class I areas that are within 300 kilometers (km):

Table 1: Distance from Facility to Class I Areas (km)

Class I Area	Distance from Facility (km)
Shenandoah National Park	41
Dolly Sods Wilderness Area (West Virginia)	113
Otter Creek Wilderness Area (West Virginia)	135
James River Face Wilderness Area	217

PSD regulations provide reviewing authority to Federal Land Managers (FLMs) of Class I areas that may be affected by emissions from the proposed facility. In accordance with Memoranda of Understanding (MOU) between DEQ and the respective FLMs, both the National Park Service (NPS) and the National Forest Service (NFS) are given a 60-day review and comment period once provided notification that the application is considered complete. Within the first 30 days of the review period, the FLMs are asked whether or not they will provide a finding of adverse impact on visibility as a result of the proposed facility. FLMs may comment on any aspect of permit processing, but are specifically charged with protecting Air Quality Related Values (AQRVs) within the Class I areas.

PSD permit review includes a rigorous analysis of Best Available Control Technology (BACT). PSD applicants are required to provide a “top down” analysis of all technically and economically feasible control technologies. The applicant is required to employ the most stringent level of control that cannot be demonstrated to be either technically or economically infeasible. Economic feasibility takes into consideration the cost of controls required at similar recently permitted facilities.

II. Introduction and Background

On February 27, 2012, the Valley Regional Office (VRO) of the Department of Environmental Quality (DEQ) received an application dated February 22, 2012, from Carmeuse requesting a PSD permit to construct and operate two new state of the art vertical lime kilns at its Winchester facility. The application was deemed complete by DEQ on November 25, 2013. A description of the various applications submitted by Carmeuse for this project is provided in section II.E. below.

A. Site Information

The Winchester facility is an approximately 670-acre parcel that is located about one mile east of Exit 323 of Interstate 81 in northern Frederick County. It is approximately six miles northeast of the center of the City of Winchester. The facility is currently used for limestone mining, limestone

processing, and lime production (although the lime kiln has not operated since November 2008). The Winchester facility began limestone quarrying operations in 1959 and the existing rotary lime kiln was constructed in 1996.

The Winchester facility currently operates under several DEQ air permitting registration numbers:

- 80504 – includes the existing rotary lime kiln and associated materials handling equipment;
- 80900 – includes the main quarrying operations, including the fine grinding plant and pug mill (permit dated August 11, 2010, as amended May 31, 2011); portable stone processing plant (permit dated August 16, 2004); and a tertiary crushing and processing plant (permit dated February 24, 2005, as amended July 31, 2006);
- 81477 – a portable railcar unloading system (permit dated July 1, 2004); and
- 81485 – a portable aggregate wash plant (permit dated September 4, 2007, as amended May 24, 2010).

The 80504 permit is the only permit that is being modified by this permitting action. However, the existing portable railcar unloading system (registration no. 81477) will be removed as part of this project, so that permit will be rescinded in the near future. Nonetheless, the emissions associated with this equipment were included in the regional emissions inventory for modeling purposes.

In addition, located immediately adjacent to Carmeuse's facility is W-L Construction & Paving's asphalt plant that is permitted under registration number 81027. This is a drum mix asphalt plant that is rated at 400 tons per hour with a 100 MMBtu/hr aggregate dryer that is permitted to burn coal, recycled used oil, distillate oil, and natural gas. W-L Construction & Paving's asphalt plant is physically contiguous to the Winchester facility; it is located on land owned by Carmeuse; and Carmeuse supplies much of the aggregate to the asphalt plant. However, W-L Construction & Paving is an independent, unrelated corporate entity from Carmeuse, and its operations fall under a different SIC code from Carmeuse's operations.

Within Virginia, in addition to the Winchester facility, Carmeuse also owns and operates a limestone mining and lime production facility in Strasburg, and a limestone crushing facility in Middletown. The Strasburg facility is permitted under registration number 80252, and it includes a rotary lime kiln. The Middletown facility is permitted under registration number 80452. Various portable material processing units are permitted under separate registration numbers and are home-based at one of these two facilities.

The UTM coordinates for the Winchester facility are 751.0 kilometers (km) East and 4,348.8 km North in UTM Zone 17. The two new lime kilns will be located at a base elevation of 625 feet above mean sea level.

There is gently rolling terrain around the proposed site. Three residences are located adjacent to the facility's main entrance on Brucetown Road (VA 672). The nearest school is Stonewall Elementary School, which is located on Martinsburg Pike (US-11), approximately 0.5 kilometers from the site perimeter and about 1.5 kilometers from the proposed vertical kilns. The nearest hospital is located in Winchester, approximately 10 kilometers from the facility. The only other significant air pollution source located within one mile of the facility is the adjacent asphalt plant described above. There are numerous significant sources of air pollution located within and near the City of Winchester.

There is one Class I area within 100 km of the facility – the northern end of the Shenandoah National Park is 41 km south of the facility.

B. Site Suitability

In accordance with Section 10.1-1307 E of the Air Pollution Control Law of Virginia, consideration has been given to the following facts and circumstances relevant to the reasonableness of the activity involved:

1. *The character and degree of injury to, or interference with safety, health, or the reasonable use of property which is caused or threatened to be caused:*

The activities regulated in this permit have been evaluated consistent with 9 VAC 5-50-260 (Best Available Control Technology) and have been determined to meet this standard where applicable. Please see Section IV.D.2 for a description of the BACT standards included in the permit.

The existing facility is classified as a major source under the PSD program because lime plants are a listed source category and the facility has the potential to emit over 100 tpy of criteria pollutants. In accordance with PSD regulations, air quality modeling was conducted to predict the maximum ambient impacts of criteria pollutants emitted by the proposed modifications to the facility. The preliminary modeling results for CO (1-hour and 8-hour averaging periods) were below applicable modeling significant impact levels (SILs) and well below applicable primary and secondary air quality standards. Accordingly, no further analyses were required for CO. In contrast, the preliminary modeling

results for SO₂ (1-hour, 3-hour, and annual averaging periods), NO₂ (1-hour and averaging periods), and PM-10 (24-hour and annual averaging periods) all exceeded the applicable SILs. Consequently, a full impact analysis was conducted for each of these pollutants and averaging periods. In addition, a full impact analysis was conducted for PM-2.5 (24-hour and annual averaging periods) because there are no applicable SILs for this pollutant. The full impacts analysis shows that predicted impacts for all pollutants and averaging periods are less than the applicable National Ambient Air Quality Standards (NAAQS). Hence, the project will not cause or contribute to a NAAQS violation. DEQ's analysis of the applicant's Class II modeling is provided in Attachment B.

Carmeuse's facility is located approximately 41 kilometers from the Shenandoah National Park (SNP), which is a protected Class I area. As a result, Carmeuse must demonstrate that emissions from its proposed project will not cause an adverse impact on air quality and air quality related values (AQRVs) within SNP, in addition to any modeling that may be warranted in other areas surrounding the proposed site. Accordingly, Carmeuse, in consultation with DEQ and NPS staff, conducted extensive modeling to evaluate air quality effects within SNP. DEQ's analysis of the applicant's Class I modeling is also provided in Attachment B.

Results of modeling conducted for emissions from the proposed modifications to the facility show compliance with the health-based NAAQS for all pollutants. Furthermore, single source and cumulative modeling analyses indicate that the proposed project will not result in a violation of any PSD increment. Accordingly, approval of the proposed permit is not expected to cause injury to or interference with safety, health, or reasonable use of property.

2. *The social and economic value of the activity involved:*

The proposed new vertical kilns will produce lime 30 to 45 percent more fuel-efficiently than the existing rotary kiln. The vertical kiln design was selected by Carmeuse largely due to its superior fuel efficiency and lower emissions per ton of lime produced, as compared to the traditional rotary kiln that is being replaced. The installation of a more efficient, less energy-intensive, and less-polluting process will provide social and environmental benefits. Economic benefits will be provided through construction jobs and approximately 25 permanent jobs once the new vertical kilns become operational.

A significant percentage of the lime produced in the proposed kilns is expected to be used for air pollution control purposes (flue gas desulfurization), which will help improve air quality in the Mid-Atlantic region. Other lime product will be used for water treatment, agricultural purposes, and soil stabilization.

3. *The suitability of the activity to the area in which it is located:*

The social and economic value of the facility submitting the application has been evaluated relative to local zoning requirements. The local official has deemed this activity not inconsistent with local ordinances. The signed Local Governing Body Certification Form is included as Attachment A.

4. *The scientific and economic practicality of reducing or eliminating the discharge resulting from the activity:*

The state minor new source review (NSR) and federal PSD permitting programs require consideration of control technology options that account for the scientific and economic practicality for reducing or eliminating emissions. By properly implementing these Regulations through the issuance of the proposed permit, the staff has addressed the scientific and economic practicality of reducing emissions associated with this project.

The permit requires numerous pollution control strategies that will result in reduction of emissions. These include pollution prevention techniques such as use of the inherently fuel efficient vertical kiln design (as compared to the efficiency of the rotary kiln that is being replaced and other traditional rotary designs). Add-on pollution control requirements include a fabric filter baghouse to control PM, PM-10, and PM-2.5 emissions from the lime kilns, and enclosures, fabric filters, wet suppression, and paving to control PM, PM-10, and PM-2.5 emissions from the materials processing and handling activities. The feasibility of obtaining further emission reductions was reviewed through the rigorous “top-down” Best Available Control Technology (BACT) requirements of PSD review. No additional controls were found to be both technically and economically feasible.

C. Project Summary

Carmeuse’s existing facility includes several related but distinct processes: limestone quarrying, limestone processing (which consists of crushing,

screening, conveying, and storage), lime manufacturing (although the rotary kiln has not operated since November 2008), and coal preparation and storage. Carmeuse proposes the following significant changes at the facility:

- Removal of the existing rotary lime kiln, with a maximum capacity to produce 20.8 tons/hr of lime, which has not operated since November 2008;
- Installation of two new vertical lime kilns, each with a maximum capacity to produce 22.0 tons/hr of lime;
- Installation of a new natural gas-fired heater for the solid fuel mill;
- Removal of the existing primary crusher and installation of a new primary crusher;
- Replacing truck hauling of kiln feed limestone with a new conveyor system;
- A new lime handling operation to further process lime that is produced offsite and then transported to the site via truck or railcar;
- Removal of certain material handling equipment (some of the existing material handling equipment will not be removed or modified) and installation of new material handling equipment; and
- Removal of the existing emergency generator and installation of one new 200-horsepower (hp) diesel-fired emergency generator.

In a lime kiln, limestone (calcium carbonate, or CaCO_3) is calcined at high temperatures (~1,900 degrees Fahrenheit) to produce lime (CaO) and carbon dioxide (CO_2). The existing rotary kiln is horizontally-oriented (approximately 350 feet long) and produces lime in a continuous process. The proposed kilns are vertically-oriented (approximately 180 feet tall) and will produce lime in a batch process that features a relatively continuous load-in of limestone. The vertical kilns are parallel flow regenerative kilns. Each kiln has two vertical shafts that are connected by a crossover channel. In the “burning shaft”, limestone feed, fuel, and hot combustion gases are combined and flow in parallel. At the same time, limestone feed in the “non-burning shaft” is preheated by combustion gases and the lime product cooling air from the “burning shaft”. The two shafts cycle between burning and non-burning modes every ten to fifteen minutes.

The new kilns will be designed to accommodate solid fuel (coal and petroleum coke) and gaseous fuel (natural gas).¹ The total permitted

¹ The initial application also called for liquid fuel (distillate oil/diesel fuel), but Carmeuse subsequently decided to eliminate liquid fuels.

emissions from the proposed project, including fuel burning and materials handling emissions, are shown below.

Table 2. Total Permitted Emissions from the Proposed Project

Pollutant	Permitted Emissions (tpy)
NO _x	336.1
CO	478.1
SO ₂	204.5
VOC	26.4
PM	108.5
PM-10	97.4
PM-2.5	57.4
Sulfuric acid mist (SAM)	6.3
GHGs	363,833

The following federal regulations apply to the proposed facility:

- PSD permitting regulations for emissions of NO_x, CO, SO₂, PM, PM-10, PM-2.5, and GHG, including Best Available Control Technology (BACT) emissions controls.
- Maximum Achievable Control Technology (MACT), 40 CFR 63, Subpart AAAAA (National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants) applies to the two proposed new lime kilns and to the related limestone handling operations.
- New Source Performance Standard (NSPS), 40 CFR 60, Subpart OOO (Nonmetallic Mineral Processing Plants) applies to certain limestone processing and materials handling equipment.
- New Source Performance Standard (NSPS), 40 CFR 60, Subpart IIII (Stationary Compression Ignition Internal Combustion Engines) applies to the proposed new emergency generator.
- Maximum Achievable Control Technology (MACT), 40 CFR 63, Subpart ZZZZ (National Emission Standards for Hazardous Air

Pollutants for Stationary Reciprocating Internal Combustion Engines) applies to the proposed new emergency generator.

- 40 CFR Part 70, Title V Operating Permit Program - An application to modify the facility's existing Title V permit is due within 12 months of the commencing operation under this PSD permit, pursuant to 9 VAC 5-80-80 C.2.

Additionally, the facility is subject to various state minor new source review permitting requirements, including state BACT for the criteria pollutants that do not trigger PSD review (VOC and SAM), and numerous general provisions.

D. Process/Equipment Description

Carmeuse has proposed installation of the following primary equipment:

- Two vertical parallel flow regenerative lime kilns (LP-VK-1 and LP-VK-2), each with a maximum capacity to produce 22.0 tons of lime per hour.

Carmeuse has proposed installation of the following ancillary equipment:

- One natural gas-fired heater to dry the solid fuel (coal/petcoke) prior to its use in the kilns, rated at 3.5 mmBtu/hr heat input (HR-610);
- One diesel-fired emergency generator, rated at 200 horsepower (EG-2);
- One primary jaw crusher (limestone) (CR-900);
- One secondary roller crusher (limestone) (RC-110);
- One two-stage roll crusher (lime) (RC-545);
- One secondary crusher (lime) (CR-901);
- Five screens (SN-120, -210, -330, -900, and -901);
- One two-deck screen (SN-902);
- Twenty-four belt conveyors (BC-xxx);

- Nine storage bins (LB-332, -334, -900, -901, -902, -903, -904, -905, and -906);
- Two skip hoists (SK-350 and SK-360);
- One screw conveyor (SC-635);
- Two bucket elevators (BE-901 and BE-902);
- Two 2,200 ton lime storage silos (LB-2303 and LB-2304);
- Three loadout spouts (LS-900, -901, and -902);
- One railcar unloader (RU-900); and
- Two pressurized solid fuel bins (DB-1, DB-2).

Carmeuse has proposed to remove the existing rotary lime kiln (LP-RK-1) and various ancillary equipment as described in Table 2-1 of its application.

Vertical Lime Kilns

The two proposed new lime kilns each have the same vertical parallel flow regenerative (PFR) design. Each kiln has two vertical shafts that are connected by a crossover channel. In the “burning shaft”, limestone feed and hot combustion gases flow in parallel. At the same time, limestone feed in the “non-burning shaft” is preheated by combustion gases and the lime product cooling air. The two shafts cycle between burning and non-burning modes every ten to fifteen minutes. Each proposed kiln has a maximum rated capacity of 528 tons of lime production per day (22.0 tons/hr). Both new kilns will be designed to accommodate solid fuel (coal and petroleum coke) and gaseous fuel (natural gas).

The PFR design is an improved and relatively new design for lime kilns. In contrast to a rotary kiln, in a vertical kiln the combustion gases travel in the same direction as the limestone feed and the lime product. The parallel flow results in optimum heating conditions. The hot combustion gasses are in contact with the limestone feed, which is capable of absorbing a large amount of heat, for a longer period of time. A vertical kiln delivers fuel via burning lances, as opposed to standard burners. The burning lances are uniformly spaced throughout the limestone feed. The lances are completely covered with stone, so there is no large

combustion area at the front of the kiln. Instead, the burning of fuel occurs in the voids between the stones. The proposed kilns have 28 individual lances (burners) in each shaft, which reduces the process temperature (as compared to rotary kilns) and spreads the heat uniformly across the shafts.

Vertical kilns have improved thermodynamic characteristics due to the regenerative preheating of the combustion air. Each vertical kiln has two shafts and combustion is cycled between these shafts every ten to fifteen minutes. Limestone feed in the preheating zone of the non-combustion shaft acts as a regenerator: it absorbs heat from the exhaust gases from the combustion shaft, and it also preheats combustion air for the following cycle.² Fuel efficiency in a vertical kiln is enhanced (as compared to a rotary kiln) by lower operating temperatures. Although calcination occurs at about 1,900 degrees Fahrenheit, the back end of a rotary kiln reaches 2,000 to 2,200 degrees. In contrast, a vertical kiln does not exceed 1,900 degrees, which results in less fuel consumption.

Moreover, vertical kilns utilize the limestone feed more efficiently. The industry standard for rotary kilns is a 2:1 limestone feed to lime product ratio. In other words, it takes 2 tons of limestone to produce 1 ton of lime in a rotary kiln. Vertical kilns, however, process the limestone more efficiently, so less limestone is needed to produce a given amount of lime. Vertical kilns are generally capable of a 1.8:1.0 limestone to lime ratio. However, to be conservative, Carmeuse has assumed a 1.9:1.0 ratio in its production and emissions calculations. For example, the limestone feed throughput limit in Condition 19 of the permit is derived as follows:

$$\frac{157,000 \text{ ton lime}}{\text{year-kiln}} \times 2 \text{ kilns} \times \frac{1.9 \text{ ton limestone}}{1.0 \text{ ton lime}} = 596,600 \text{ ton limestone}$$

Combustion and cooling air is metered into the kiln in precise amounts with positive displacement blowers. Limestone feed and fuel are metered into the kiln in precise amounts through weigh vessels. A computer controls all of the inputs into each

²

By way of contrast, conventional rotary lime kilns are counter-flow systems. The combustion gases and the product travel in opposite directions. Fuel is introduced into a rotary kiln via a single large high temperature burner in a combustion chamber over the finished product. A rotary kiln acts as a large, open combustion chamber. Only about 10% of its volume contains limestone feed and lime product; the balance remains open for the combustion of the fuel.

combustion cycle. The amount of combustion air can be controlled by the operator to adjust the flame length within the bed of limestone feed.

Limestone Processing and Handling

The existing facility includes an open pit limestone quarry and associated equipment, such as rock crushers, conveyors, screens, and limestone stockpiles. The existing primary crusher will be replaced by a new primary jaw crusher with a larger capacity of approximately 5,000,000 tpy.³ Certain other equipment will be upgraded to modernize the quarrying and materials handling processes that will support the two new vertical lime kilns.

Lime Handling

The existing facility includes lime handling equipment that serves the existing rotary lime kiln. Additional lime processing and loading equipment will be added because the two new vertical kilns can produce different grades of lime.

Carmeuse is also seeking authorization to implement an additional lime handling process. This process will enable the facility to receive via truck or railcar lime that is produced offsite, and then to further process the lime to meet specific customer needs. This process has two purposes: it will enable Carmeuse to sell lime before the new vertical kilns become operational, and it will allow the facility to continue selling lime whenever one or both kilns are offline. This additional lime handling process involves the installation of the following additional equipment:

- Two bucket elevators (BE-901 and BE-902);
- One 2-deck screen (SN-902);
- One secondary crusher (CR-900);
- One belt conveyor (BC-914);
- One 120-ton loadout weigh bin (LB-904);
- One loadout spout (LS-901);
- One truck dump hopper (HOP-900);
- One railcar unloader (RU-900); and
- Three additional dust collectors (DC-900, -901, and -902).

³ 950,000 tpy of this capacity will be used in the lime kilns or processed on related equipment (per Condition 42 of the permit). The remainder of this capacity is addressed in the permit for the aggregate plant, which is under Registration Number 80900.

Fabric filters will control particulate matter emissions from this new process. The lime throughput limit in Condition 71 of the permit of 471,000 tons per year reflects the production limit for both kilns (314,000 tpy) and an additional 157,000 tpy of lime that could be brought in from offsite and further processed on this equipment.

Solid Fuel Handling

The existing facility uses coal as a fuel for the existing rotary kiln. Most of the existing coal handling equipment will remain in place. New storage bins and associated equipment will be added to allow the facility to also use petroleum coke (petcoke) as a solid fuel for the two new vertical kilns. A new natural gas-fired, 3.5 MMBtu/hr solid fuel heater will be added to the solid fuel milling process. The two proposed vertical lime kilns are the only equipment at the facility that will use solid fuel.

Diesel-Fired Emergency Generator

Carmeuse proposes to remove the facility's existing 150-hp diesel-fired emergency generator and replace it with one new 200-hp diesel-fired emergency generator. The Company is requesting authorization to operate the emergency generator for up to 500 hours per year. The emergency generator will operate ancillary equipment to maintain the safety of personnel and process equipment. The proposed diesel-fired generator was manufactured pursuant to NSPS Subpart IIII for Stationary Compression Ignition Internal Combustion Engines for the 2013 manufacturing year.

E. Permitting Timeline

A pre-application meeting was held at VRO on February 16, 2012. NPS representatives participated in this meeting by telephone. Carmeuse's application for the PSD permit is dated February 22, 2012, and was received by VRO on February 27, 2012. DEQ's Initial Letter of Determination (ILOD), which provides DEQ's initial review of the application, was sent to Carmeuse on March 28, 2012. Carmeuse's response to DEQ's ILOD is dated May 25, 2012, and was received by VRO on May 29, 2012.

Carmeuse submitted an amended application dated July 31, 2012, that presented alternative operating scenarios for limestone crushing and lime crushing that the Company wanted permitted. By the fall, Carmeuse had

refined its plans and determined which of the alternative operating scenarios it wanted permitted. Consequently, Carmeuse submitted a revised comprehensive application dated October 12, 2012, that was received by DEQ on October 22, 2012. However, the October 2012 application included a “base case” for lime handling operations and an “alternative operating scenario” that allowed for the delivery of lime to the facility by truck and railcar. Another face-to-face meeting was held at DEQ on November 6, 2012, to discuss the application processing timeline (including the required public notices and meetings) and various substantive issues.

The following spring, the company further refined its engineering for this project and decided to use a different manufacturer for the vertical lime kilns, which resulted in enough changes (including a reduction from three emergency generators to two) to warrant the submission of another revised, comprehensive application. Carmeuse’s application dated May 13, 2013 was received by DEQ on that same day. This application did not include any alternative scenarios, and the company seeks authorization for delivery of lime via truck and railcar as part of this project.

Subsequently, the project experienced further refinement, including the removal of certain materials handling emission points (for example, one conveyor was moved underground, and the number of coke bins was reduced from four to two) and the reduction in emergency generators from two to one. Moreover, after submission of its May 13, 2013 application, the company had submitted amendment and supplemental information about ten times, resulting from refinements to the modeling protocols for PM_{2.5}, and additional information was still required. For these reasons, DEQ and Carmeuse agreed that another comprehensive revised application would be appropriate. This application is dated July 26, 2013, and was received by DEQ on August 1, 2013. Another meeting was held between Carmeuse and DEQ, including management from both parties, on July 26, 2013 to discuss the permitting timeline, including the required public participation activities and FLM involvement.

At that meeting, Carmeuse accepted that the permit could not be issued by November 26, 2013, due to the extensive public participation requirements for PSD permits. Consequently, the project would not net out of PSD review for sulfur dioxide (this is discussed in more detail in section IV.A below). Therefore, sulfur dioxide needed to be added to the Class II and Class I modeling, and a top-down BACT analysis was required for sulfur dioxide. Because of these additions and other changes to the application, Carmeuse submitted another revised comprehensive application dated September 24, 2013. This is the official application of record for this permit. All of the earlier applications described above have been

superseded by the September 24, 2013 application, and are no longer relevant to this permit.

All amendment and supplemental information that had been submitted previously to DEQ has been incorporated into each subsequent revised comprehensive application, so those previous submissions do not need to be separately identified. The application was deemed complete on November 25, 2013, upon submission of the final Class II modeling report, which included sulfur dioxide (the final Class I modeling report was received earlier).

This project has evolved significantly during the permitting process, as reflected in the various applications that have been submitted. This project has experienced numerous design changes, including two different manufacturers for the vertical kilns; numerous changes in the materials handling equipment; and a reduction in the number of emergency generators from three to two, and then to just one.

Several additional meetings were held throughout the permitting process, usually involving Carmeuse's environmental manager and DEQ's air permitting staff.

Carmeuse's Class II modeling protocol was received by DEQ's Office of Air Quality Assessments (AQA) on May 2, 2012. The AQA approved Carmeuse's Class II modeling protocol in January 2013. Carmeuse's Class I modeling protocol was received by AQA on February 19, 2013, and the AQA approved it that same month. Representatives of the FLM for the Shenandoah National Park participated in the review of the Class I modeling protocol. Carmeuse's preliminary Class II modeling results were received by AQA on July 23, 2013, and the final Class II modeling report was received by AQA on November 25, 2013. Carmeuse's preliminary Class I modeling results were received by DEQ on July 26, 2013, and the final Class I modeling report was received by DEQ on November 25, 2013. The AQA approved all of the modeling in its "Technical Review..." memorandum dated December 10, 2013 (which is included as Attachment B).

Carmeuse intends to commence construction on the proposed project as soon as practicable after issuance of the PSD permit. Commercial operation of the new vertical lime kilns had been expected to begin in approximately September 2014, although this date is largely dependent on when the PSD permit is issued and construction commences.

III. Emissions Calculations

A. Criteria Pollutants

Proposed emissions are from the two proposed vertical lime kilns, other fuel burning equipment (the solid fuel dryer and the diesel emergency generator), and the materials processing and handling activities.

Emissions from the materials processing and handling activities – the primary crusher, screens, conveyors, etc. – are limited to the various particulate matter emissions (total PM, PM-10, and PM-2.5) because all materials processing and handling equipment is powered by electricity from the grid (as opposed to being powered by integrated engines).

Emissions from the vertical lime kilns consist of products of combustion and CO₂ emissions resulting from the calcination process. Table 3 below provides the maximum hourly and annual emissions from the kilns.

Emissions calculations conducted by Carmeuse, and verified by DEQ, are included in Attachment C.⁴

Table 3: PTE for the Lime Kilns

Pollutant	Each Kiln ¹		Total for Both Kilns	
	lb/hr	tpy	lb/hr	tpy ²
NO _x	46.95	167.52	93.9	335.0
CO	66.0	238.26	132.0	476.5
SO ₂	28.6	102.18	57.2	204.4
VOC	3.6	13.00	7.1	26.0
PM/PM10	7.2	25.87	14.3	51.7
PM2.5	5.6	20.15	11.2	40.3
H ₂ SO ₄	0.9	3.16	1.8	6.3
GHG (CO ₂ e)	50,724	180,991	101,448	361,982

1 Values are taken from Table B.4-2 in the application, which assumes 357 days of operation per year.

2 Totals include startup/shutdown emissions for 8 days per year, from Table B.4-5.

The only emission rates shown in Table 3 above that are different from the calculations provided in the application are the hourly and annual NO_x emissions. In Table B.1-4 of the application, Carmeuse shows a summary of NO_x emissions test data consisting of 21 tests on vertical kilns in Europe while burning petcoke. After adding a safety factor, Carmeuse derived a proposed NO_x emission limit of 2.50 lb/ton of lime produced.

⁴ Note that in the sample calculations following Table B.1-2, the airflow and temperature values shown for the VOC emission factor calculation are for the specific kiln that was tested, which are different from the proposed kilns.

In contrast, DEQ used the European emission limit of 350 milligrams per normal cubic meter (mg/nm³) because the proposed kilns have been designed by a European company and their vertical kilns presumably are capable of meeting the European standard. Using the expected operational parameters for the proposed kilns for airflow (48,000 ft³ per minute) and temperature (248 degrees Fahrenheit, which equals 393 degrees Kelvin), DEQ derived a NO_x emission limit of 2.13 lb/ton of lime produced, which is the NO_x emission limit in the proposed permit:

$$\text{NO}_x = \frac{350\text{mg}}{1\text{nm}^3} * \frac{1\text{g}}{1000\text{mg}} * \frac{1\text{lb}}{453.4\text{g}} * \frac{48,000\text{ft}^3}{1\text{min}} * \frac{293\text{K}}{393\text{K}} * \frac{1\text{m}^3}{35.3\text{ft}^3} * \frac{60\text{min}}{1\text{hr}} * \frac{1\text{hr}}{22\text{ ton lime}} = \frac{2.134\text{lb}}{\text{ton lime}}$$

Carmeuse requested annual emission limits in the permit that are combined for both lime kilns. However, since the two lime kilns will be constructed sequentially instead of simultaneously, the annual emission limits established in Condition 27 of the permit are specified for each kiln individually.

There are also fuel combustion emissions from the solid fuel dryer (HR-610) and the emergency generator (EG-2). Emissions from the solid fuel dryer are limited because this unit will burn only natural gas and due to its small size (3.5 MMBtu/hr). These emissions are shown in Table 6 below.

Emissions from the emergency generator are based on the NSPS Subpart III limits for Stationary Compression Ignition Internal Combustion Engines. The emergency generator will use ultra-low sulfur distillate oil having a maximum sulfur content of 0.0015% by weight per federal requirements. Annual emissions are calculated based on 500 hours of operation, and are shown in Table 4 below. Actual usage of the emergency generator, and thus its emissions, are expected to be much lower than these values.

Table 4: PTE for the Emergency Generator

Pollutant	EG-2 (tpy)
NO _x ^a	0.33
CO ^a	0.29
SO ₂ ^b	0.10
VOC ^{a, c}	0.33
PM/PM-10/ PM-2.5 ^a	0.02
GHG (CO ₂ e)	57.3

^a Based on emission factors from NSPS Subpart IIII limits for Stationary Compression Ignition Internal Combustion Engines (ref. 40 CFR 89.112 Table 1) and 500 hours of operation annually. NO_x emissions are assumed to be worst case as entire NMHC + NO_x emission standard is used for NO_x emission factor.

^b lb/MMBtu based on fuel sulfur.

^c VOC = non-methane hydrocarbons (NMHC).

Materials processing operations at the facility include processing the limestone feed material, the solid fuels (coal and petcoke), and the lime product. These materials processing operations are significant sources of PM, PM-10, and PM-2.5. The other significant source of these three related pollutants is dust from truck traffic on unpaved roads within the facility. These emissions are set forth in Table 5 below.

Table 5: PTE for the Materials Processing Operations (tpy)

Pollutant	Limestone Handling ¹	Solid Fuel Handling ²	Lime Handling ³	Road Dust ⁴	Total
PM	19.91	6.15	28.11	8.57	62.7
PM-10	12.11	6.12	28.151	2.24	48.6
PM-2.5	3.36	2.44	11.24	0.29	17.4

- 1 Includes all limestone handling emissions points (see Table B.6-2 in the application), all limestone storage piles (Table B.6-3), and DC-906 (Table B.6-3). These values are based on the 950,000 tpy throughput limit established in Condition 42 of the permit. However, the modeling used the full 5,000,000 capacity of the new primary crusher (CR-900).
- 2 Includes the enclosed coke pile and dump hopper (see Table B.7-2 in the application), the coal/coke dust collectors (Table B.7-3), and the outdoor coal/coke pile (Table B.7-6).
- 3 Includes the twelve lime handling dust collectors (see Table B.8-1 in the application).
- 4 See Table B.9-2 in the application.

A summary of estimated annual emissions from the proposed facility, showing the contribution from each emission unit type, is shown in Table 6 below.

Table 6: Criteria Pollutant Emissions from the Proposed Facility (tpy)

Pollutant	Both Vertical Lime Kilns	Emergency Generator	Solid Fuel Dryer ¹	Materials Processing Operations	Total
NO _x	335.0	0.3	0.8	0	336.1
CO	476.5	0.3	1.3	0	478.1
SO ₂	204.4	0.1	0.0	0	204.5
VOC	26.0	0.3	0.1	0	26.4

PM	51.1	0.0	0.1	62.8	114.0
PM-10	51.1	0.0	0.1	48.7	99.9
PM-2.5	39.8	0.0	0.1	17.4	57.3
H ₂ SO ₄	6.3	0.0	0	0	6.3
GHG	361,982	57	1,794	0	363,833

¹ Values from Table B.7-5 of the application and DEQ's DORONG emissions spreadsheet.
Note that PM/PM-10/PM-2.5 emissions resulting from the handling of the solid fuel are controlled by a fabric filter.

B. HAPs/Toxic Pollutants

Carmeuse provided emissions calculations for hazardous air pollutant (HAP) emissions. Table B.4-2 of the application describes the primary HAP emissions from the facility, which are hydrochloric acid (HCl) and hydrofluoric acid (HF) from the two lime kilns. Table B.4-7 summarizes emissions of all other HAP from the kilns and other emission sources. Emissions of HCl from the kilns will be 24.5 tpy, and emissions of HF from the kilns will be 3.1 tpy. Therefore, the potential HAP emissions from the proposed vertical kilns exceed both major source thresholds for HAPs, i.e., 10 tons per year of a single HAP (24.5 tpy of HCl) and 25 tons per year of all HAPs combined (27.6 tpy of HCl and HF). Accordingly, Carmeuse's Winchester facility is a major source of HAP, and the major source MACT for lime plants (Subpart AAAAAA) is applicable to the proposed vertical lime kilns (as described in section IV.D.6 below).

IV. Regulatory Review and Considerations

A. Criteria Pollutants

The existing facility meets the definition of "major stationary source" under 9 VAC 5 Chapter 80 Article 8 (Prevention of Significant Deterioration (PSD)) because it is a lime plant with the potential to emit (PTE) of more than 100 tons per year of a regulated pollutant. See 9 VAC 5-80-1615 "major stationary source" a(1)(n) and Table 6 above (showing that the PTE for NO_x, CO, SO₂, and PM exceed 100 tpy). Accordingly, the emissions from the proposed project must be evaluated to determine whether there is a significant net emissions increase that subjects the project to PSD permitting.

Applicability of PSD review is evaluated on a pollutant-specific basis. 9 VAC 5 Chapter 80 Article 8 defines "significant" emissions increase levels for several regulated pollutants; pollutants for which the proposed net emissions increase exceeds significant levels are subject to PSD review.

Table 7 below compares the maximum proposed emissions increases from Carmeuse's proposed project with PSD significant increase levels. This comparison is commonly referred to as "Step 1" in the PSD applicability analysis. The PTE values shown in Table 7 are taken from Table 6 above, and they include the two proposed vertical kilns, all materials processing equipment, and all ancillary equipment. As shown in Table 7 below, the emissions increase is significant for the following pollutants: NO_x, CO, SO₂, PM, PM-10, PM-2.5, and GHG. The only criteria pollutants for which there is not a significant emissions increase are VOC and SAM. Accordingly, VOC and SAM are not subject to PSD permitting.

**Table 7: PSD Applicability Step 1 –
Significant Emissions Increase (tpy)**

Pollutant	Potential to Emit	PSD Significant Increase Levels	Is Emissions Increase Significant?
NO _x	336.1	40	Yes
CO	478.1	100	Yes
SO ₂	204.5	40	Yes
VOC (ozone)	26.4	40	NO
PM	114.6	25	Yes
PM-10	100.5	15	Yes
PM-2.5	57.8	10	Yes
H ₂ SO ₄ (SAM)	6.3	7	NO
GHG	363,833	75,000	Yes

In order for PSD to apply to the project, there must also be a significant net emissions increase for each given pollutant. This calculation includes emissions from the proposed project and all contemporaneous, creditable emissions increases and decreases. The contemporaneous period is defined by DEQ's regulations as beginning on "the date five years before construction on the particular change commences". (See 9VAC5-80-1615, "net emissions increase", subsections b and c; see also DEQ PSD Guidance, p.3-12.)

There are no contemporaneous, creditable emissions increases or decreases for this project. Therefore, the Step 1 significant emissions increase and the Step 2 significant net emissions increase are the same for all pollutants. The Step 2 significant net emissions increases are shown in Table 8 below.

**Table 8: PSD Applicability Step 2 –
Significant Net Emissions Increase (tpy)**

Pollutant	Potential to Emit	Contemporaneous Emissions Changes	Net Emissions Increase	PSD Significant Increase Levels	Is Net Emissions Increase Significant?
NO _x	336.1	-	336.1	40	Yes
CO	478.1	-	478.1	100	Yes
SO ₂	204.5	-	204.5	40	Yes
PM	114.6	-	114.6	25	Yes
PM-10	100.5	-	100.5	15	Yes
PM-2.5	57.8	-	57.8	10	Yes

Throughout much of this permitting process, Carmeuse intended to include emissions decreases from the shutdown of its existing rotary kiln in the Step 2 analysis, which would have allowed the project to net out of PSD review for sulfur dioxide. Since the existing rotary kiln last operated on November 27, 2008, construction must have commenced on the proposed vertical kilns by November 26, 2013, in order to include the rotary kiln shutdown in the contemporaneous period. However, since that date has now passed, the project will not net out of PSD review for sulfur dioxide. Carmeuse's latest revised comprehensive application includes a top-down BACT analysis for sulfur dioxide, and its modeling includes this pollutant as well.

Because there are no contemporaneous, creditable emissions decreases, all pollutants for which there is a Step 1 significant emissions increase also have a Step 2 significant net emissions increase, and therefore are subject to PSD permitting. GHG is not included in Table 8 because GHG emission data for the 2007-08 timeframe is not available and Carmeuse has conceded PSD applicability for GHG for the proposed project.

To summarize, the criteria pollutants subject to PSD review are NO_x, CO, SO₂, PM, PM-10, PM-2.5, and GHG. The criteria pollutants that are not subject to PSD are VOC and SAM. Of the pollutants subject to PSD, the PSD regulations require modeling analysis to demonstrate compliance with the NAAQS and PSD increments for NO_x, CO, SO₂, PM-10, and PM-2.5 (there are no modeling requirements for PM). The modeling results are discussed in section C below and in Attachment B.

B. HAPs/Toxic Pollutants

As described above, the proposed vertical lime kilns (LP-VK-1, LP-VK-2) are a major source of HAP. Therefore, the vertical lime kilns are subject to the Lime MACT (which is described below). Also as discussed above and below, the diesel emergency generator (EG-2) is subject to the Subpart ZZZZ MACT. Pursuant to 9 VAC 5-60-300 C.4, these units are exempt from the state toxic pollutant regulations set forth in 9 VAC 5 Chapter 60 because they are subject to federal HAP regulations.

The only other fuel-burning unit in this project is the new natural gas-fired 3.5 MMBtu/hr solid fuel dryer (HR-610). Although gas-fired fuel-burning units with a maximum heat input rate of less than 50 MMBtu/hr are exempt from DEQ permitting regulations for criteria pollutants (per 9 VAC 5-80-1105 B.1.a.(4)), the unit's HAP emissions must be evaluated against DEQ's state toxics exemption levels (as set forth in the table "DEQ State Toxics Exemption Levels & SAAC" dated 10/24/11). As shown in Table 9 below, using AP-42 emission factors for natural gas burners, the maximum potential HAP emissions from the solid fuel dryer are below the applicable exemption levels. Therefore, this unit is not subject to the state toxics regulations.

Table 9: HAP Emissions from the Solid Fuel Dryer (HR-610)

HAP	HR-610 Emissions (lb/hr) (tpy)		Exemption Levels (lb/hr) (tpy)		Exempt?
Arsenic	6.8E-07	3.0E-06	1.3E-02	2.9E-02	Yes
Benzene	7.2E-06	3.1E-05	2.1E+00	4.6E+00	Yes
Beryllium	4.1E-08	1.8E-07	1.3E-04	2.9E-04	Yes
Cadmium	3.8E-06	1.6E-05	3.3E-03	7.3E-03	Yes
Chromium (VI)	4.8E-06	2.1E-05	3.3E-03	7.3E-03	Yes
Cobalt	2.9E-07	1.3E-06	3.3E-03	7.3E-03	Yes
Dichlorobenzene	4.1E-06	1.8E-05	2.2E+01	6.6E+01	Yes
Formaldehyde	2.6E-04	1.1E-03	8.3E-02	1.7E-01	Yes
Hexane	6.1E-03	2.7E-02	1.2E+01	2.6E+01	Yes
Lead	1.7E-06	7.5E-06	9.9E-03	2.2E-02	Yes
Manganese	1.3E-06	5.7E-06	3.3E-01	7.3E-01	Yes
Mercury	8.9E-07	3.9E-06	6.6E-04	1.5E-03	Yes
Naphthalene	2.1E-06	9.1E-06	2.6E+00	7.5E+00	Yes
Nickel	7.2E-06	3.1E-05	6.6E-03	1.5E-02	Yes
POM	3.0E-07	1.3E-06	2.6E+00	7.5E+00	Yes
Selenium	8.2E-08	3.6E-07	1.3E-02	2.9E-02	Yes
Toluene	1.2E-05	5.1E-05	1.9E+01	5.5E+01	Yes

Since each fuel-burning unit is individually exempt as described above, the proposed project is not subject to the state toxic pollutant regulations set forth in 9 VAC 5 Chapter 60.

C. Modeling Results

The initial Class I and Class II air quality analyses were received by DEQ on July 25 and July 23, 2013, respectively. The Class I and Class II air quality modeling analyses conform to 40 CFR Part 51, Appendix W - Guideline on Air Quality Models and were performed in accordance with their respective approved modeling methodology that were included in a protocol that was submitted in advance by the Company.

The air quality modeling analyses results show compliance with all applicable NAAQS and PSD increments. DEQ's Office of Air Quality Assessments (AQA) reviewed and approved the applicant's Class I and Class II modeling analyses. AQA issued its "Technical Review of the Air Quality Analysis in Support of the PSD Application [for this project]" on December 10, 2013. This document is included as Attachment B.

D. Control Technology Standards and Analysis

1. BACT vs. LAER

The Federal permitting process involves two methods of control technology review: Best Available Control Technology (BACT) and Lowest Achievable Emission Rate (LAER). In geographic locations where ambient pollutant concentrations exceed the NAAQS, permit applicants are required to meet LAER. LAER is defined as the lowest emission limit achieved in practice on a similar design. Only technical and environmental factors are considered, without regard to cost. In areas where pollutant concentrations are within the NAAQS, the applicant must apply BACT. BACT represents the most stringent emission limit that is technically, environmentally, and economically feasible. EPA policy requires that LAER is the first consideration in the BACT analysis. Only when LAER is proven to be environmentally or economically infeasible may BACT be less stringent than LAER. However, in no case may BACT result in an emission rate less stringent than required by federal regulations such as NSPS or MACT requirements. Frederick County is considered in attainment for all NAAQS. Therefore a BACT analysis (rather than LAER) is required for emission controls and consequently economic factors are considered.

2. BACT requirements

The EPA guidance document New Source Review Workshop Manual: Prevention of Significant Deterioration and Nonattainment Area Permitting (Draft, October 1990) prescribes that for PSD permitting, the most stringent BACT review, otherwise known as “top-down” review, be conducted. Per EPA guidance, the “top-down” BACT analysis consists of the following five steps:

1. Identify all potentially applicable control technologies;
2. Eliminate technically infeasible options;
3. Rank the remaining options by effectiveness;
4. Evaluate economic, environmental, & energy impacts; and
5. Select BACT control(s) and establish BACT emission limit(s).

Under Step 4, the most stringent or “top” alternative is evaluated first and must be established as BACT unless it is demonstrated that energy, environmental, or economic impacts justify that the most stringent technology is not feasible. If the most stringent option is eliminated, then the next most stringent control option is considered until BACT is established.

All pollutants subject to PSD review are subject to a “top-down” BACT analysis, as BACT is established on a pollutant-specific basis. For the proposed new vertical lime kilns, the pollutants subject to BACT are PM/PM-10/PM-2.5, CO, NO_x, SO₂, and GHGs (CO₂, CH₄, and N₂O). Emission units and pollutants addressed in the BACT determination submitted by Carmeuse consist of the vertical lime kilns (all pollutants listed above); the diesel emergency generator (all pollutants listed above); solid fuel dryer (all pollutants listed above); and the materials handling processes (only PM/PM-10/PM-2.5).

PSD procedures require that the BACT cost feasibility analysis be based upon recent permit determinations for similar facilities. Federal guidance is clear that there can be no fixed or “bright line” cost established as representative of BACT. Rather, the cost of reducing emissions, expressed in dollars per ton, is to be compared with the cost incurred by other sources of the same industry type. A listing of BACT determinations included in EPA’s RACT/BACT/LAER Clearinghouse (RBLC) for similar facilities is included as Appendix C in Carmeuse’s application. Due to the length of time between submission of Carmeuse’s initial

application and its final revised comprehensive application (17 months), DEQ required Carmeuse to update its RBLC searches for its final revised comprehensive application.

The RBLC includes two kinds of lime kilns that are quite different in their design and function: kilns that convert crushed limestone into lime (which is what Carmeuse proposes to do) and kilns at pulp mills that recover calcium (by converting it to lime) from the kraft pulping process. EPA recognized the significant differences in these kilns by establishing separate process type codes for them in the RBLC: 90.019 for limestone-to-lime kilns, and 30.231 for kraft lime kilns. Due to their significant differences, both Carmeuse and DEQ reviewed only the limestone-to-lime kilns (90.019) in the following BACT analysis and determinations.

A search of the RBLC under process type code 90.019 shows fifteen BACT determinations for projects including limestone-to-lime kilns within the past ten years. (EPA describes the 90.019 process type category as “Lime/Limestone Handling/Kilns/Storage/Manufacturing”, so it includes numerous projects that do not include lime kilns.) However, only two of these fifteen kilns are vertical kilns similar to Carmeuse’s proposed kilns; the rest are the more traditional rotary design. Consequently, some of the pollution control technologies and emission limits established for rotary kilns that are in the RBLC may not be directly applicable to the proposed vertical kilns.

The two vertical kilns are Graymont’s facility in Pleasant Gap, Pennsylvania (permitted in 2012) and Chemical Lime’s facility in Clifton, Texas (permitted in 2010). While the Texas facility is operational, to DEQ’s knowledge, construction has not yet commenced on the Pennsylvania facility.

Vertical Lime Kilns

PM/PM-10/PM-2.5 control

The pollutant of greatest concern generated by the vertical lime kilns is particulate matter (PM), which consists of three separate but related pollutants: total PM, PM-10, and PM-2.5. Although these three pollutants are regulated independently under both state and federal regulations, DEQ is addressing them together herein because the control technology selected below as BACT – a baghouse – controls all three pollutants with similar efficiency.

Particulate matter is generated within the vertical kilns from both the combustion of fuels and from the calcining process itself. The generation of additional particulate matter from the calcining process causes the uncontrolled emissions of PM/PM-10/PM-2.5 from lime kilns to be significantly greater than from a boiler burning the same amount of solid fuel.

PM-10/PM-2.5 emissions consist of a filterable fraction and a condensable fraction (PM is regulated for only filterables). The filterable fraction generally results from the physical degradation of solid materials, such as chunks of limestone and lime colliding within the kiln, causing small pieces to break off. When burning solid fuel, the filterable fraction may also include tiny particles of fuel that are not completely combusted. The condensable fraction generally results from chemical reactions where gases react to form fine particles. In a lime kiln, sulfur that is present in the limestone feed and/or the fuel can form fine particles within the kiln and/or as the flue gas cools down.

Four control technologies were identified by Carmeuse as being potentially available to reduce particulate matter emissions from the kilns:

1. Baghouse (>99% efficiency);
2. Electrostatic Precipitator (ESP) (>99% efficiency);
3. Wet Scrubbing (up to 99% efficiency); and
4. Venturi Scrubber (<90% efficiency).

(1) Baghouse. Carmeuse has proposed the use of a baghouse as BACT for PM/PM-10/PM-2.5. Since this is the most efficient technology available and is commonly selected as BACT for lime kilns (as shown in the RBLC), DEQ agrees that a baghouse constitutes BACT for PM/PM-10/PM-2.5. Consequently, the other three alternatives – each of which have been shown to be equally or less effective than a baghouse – do not need to be discussed herein.

A baghouse consists of numerous individual fabric filters that are arrayed in rows and enclosed in a housing. Flue gas enters one side of the baghouse and passes through one of the individual fabric filters before being drawn out of the other side of the baghouse. Particulate matter is captured on the outside surface of the fabric filters, where it forms a particulate cake. Periodically, the particulate cake is removed by shaking or pulsing the fabric filters, which causes the cake to fall into a collection bin at the

bottom of the baghouse. The cleaning frequency is managed to balance the pressure drop across the fabric filters (which impacts the energy required to draw the flue gas through the baghouse) versus the wear and tear on the bags resulting from the cleaning process. Baghouses generally achieve at least 99% and frequently up to 99.9% reduction in PM/PM-10/PM-2.5 emissions.

EPA's MACT standard for lime manufacturing plants (Subpart AAAAA) includes an emission limit for PM of 0.10 lb PM per ton of stone feed (tsf). (See 40 CFR §63.7090(a) and Table 1 to Subpart AAAAA of Part 63.)

Carmeuse proposes an emission limit for filterable PM/PM-10/PM-2.5 of 0.010 gr/dscf, which is the outlet grain loading rate for the baghouse. This value represents what is achievable by the baghouse and is consistent with previous BACT determinations over the past decade for lime kilns as specified in the RBLC. This proposed emission limit is more stringent than the MACT limit of 0.10 lb PM/tsf.⁵ Compliance with this MACT is based on EPA Method 5, which determines only the filterable portion of PM. Accordingly, DEQ agrees that BACT for filterable PM/PM-10/PM-2.5 is 0.010 gr/dscf.

The filterable only PM emission limit for the kilns that is established in Condition 27 of the permit is calculated as follows:

$$596,600 \text{ tons limestone} \times \frac{0.076 \text{ lb PM}}{\text{ton limestone}} \times \frac{1 \text{ ton}}{2000 \text{ lb}} = 22.6 \text{ ton PM}$$

The condensable PM/PM-10/PM-2.5 emissions will be partially controlled through the inherent scrubbing that occurs within the vertical kilns, which is described below in the SO₂ BACT discussion.

Carmeuse proposes a total (filterable and condensable) PM/PM-10/PM-2.5 emission limit of 0.33 lb/ton of lime produced, and filterable limits of 0.010 gr/dscf for PM/PM-10, and 0.004 gr/dscf for PM-2.5. Only recently have permit limits been established for condensable PM/PM-10/PM2.5, and consequently, the RBLC does not include any lime kilns with emission limits that expressly include condensables. While Graymont's Pennsylvania facility has

⁵ $0.01 \text{ gr/scf} \times 30,759 \text{ scf/min} \times 60 \text{ min/hr} \times \text{lb}/7000 \text{ gr} \times \text{day}/440 \text{ ton lime} \times 24 \text{ hr/day} = 0.144 \text{ lb PM/ton lime}$
 $0.144 \text{ lb PM/ton lime} \times 1 \text{ ton lime}/1.9 \text{ ton limestone} = 0.076 \text{ lb PM/ton limestone(tsf)}$

lower filterable limits, that facility is permitted to burn only natural gas, so its particulate matter emissions will inherently be lower than any facility burning solid fuels such as Carmeuse.⁶

Accordingly, DEQ determines that BACT for total PM (filterable only) is 0.010 gr/dscf; for PM-10 is 0.010 gr/dscf (filterable) and 0.33 lb/ton lime (filterable and condensable); and for PM-2.5 is 0.004 gr/dscf (filterable) and 0.25 lb/ton lime (filterable and condensable).

Compliance with the PM/PM-10/PM-2.5 emission limits shall be determined through periodic stack testing using the appropriate EPA test methods. A Continuous Opacity Monitoring System (COMS) and periodic visible emissions evaluations shall be used to determine compliance with the 5% visible emission limit.

Carbon Monoxide (CO) control

Carbon monoxide is generated within the vertical kilns from both the incomplete combustion of fuels and from the calcining process itself. The generation of additional CO from the calcining process due to incomplete oxidation of the carbon in the limestone causes the uncontrolled emissions of CO from lime kilns to be significantly greater than from a boiler consuming the same amount of solid fuel.

The primary factors influencing the generation of CO emissions due to incomplete combustion of the fuel are temperature and residence time within the combustion zone. Variations in fuel carbon content have relatively little effect on overall CO emissions. Generally the effect of the combustion zone temperature and residence time on CO emissions generation is the exact opposite of their effect on NO_x emissions generation. Higher combustion zone temperatures and residence times lead to more complete combustion and lower CO emissions, but higher NO_x emissions.

Carmeuse identified three potential control technologies for CO:

1. Thermal Oxidation (99% reduction);
2. Oxidation Catalyst (up to 95% reduction); and
3. Good Combustion Practices (<90% reduction).

⁶ For unknown reasons, EPA's RBLC does not provide PM/PM-10/PM-2.5 limits for Chemical Lime's vertical kiln in Texas.

(1) Thermal Oxidation. Thermal oxidation is a tailpipe control that is commonly used to reduce VOCs by oxidizing the carbon to CO₂. It involves routing exhaust gas from the kiln through an afterburner, flare, or similar fuel-burning device to generate the high temperatures required to ensure complete oxidation, usually around 1500 degrees F. Similarly, thermal oxidation can be used to oxidize CO to CO₂. Because it is a tailpipe control that can be utilized on virtually any exhaust gas stream and there are no limitations posed by the lime kiln exhaust, thermal oxidation is technically feasible. (However, based on its absence from the RBLC, it appears that thermal oxidation has not yet been demonstrated on a lime kiln.) Thermal oxidation can achieve at least 99% elimination of CO, provided that the temperature is high enough and the residence time is long enough.

Carmeuse performed a simplified cost analysis for thermal oxidation. Considering only annual costs for the natural gas to fire the afterburner (excluding capital and construction costs, non-fuel operational costs, and maintenance costs), Carmeuse estimates the cost of thermal oxidation to be approximately \$11,800/ton of CO destroyed. Carmeuse asserts that this cost renders thermal oxidation economically infeasible.

DEQ agrees that for this project, thermal oxidation is economically infeasible for CO control. DEQ also observes that the negative environmental impacts from the additional fuel usage and the generation of additional pollutants – NO_x from the high combustion temperatures; CO₂ from the burning of the natural gas; and CO₂ resulting from the oxidation of CO – outweigh the environmental benefit of reducing the CO emissions since CO is not a significant issue in Virginia (as compared to the contribution of VOC to ground-level ozone formation, which is usually the target pollutant for thermal oxidation).

(2) Oxidation Catalyst. An oxidation catalyst is a tailpipe control that reduces CO emissions by routing exhaust gas from the kiln through a catalyst that oxidizes CO to CO₂. The oxidation of CO to CO₂ utilizes the excess air (oxygen) that is present in the exhaust gas, and the catalyst lowers the activation energy (i.e., temperature) that is required for the reaction to occur. Technical factors relating to this technology include the catalyst reactor design, optimum operating temperature, back pressure loss to the system, catalyst life, and potential collateral increases in emissions of PM and SAM.

CO catalytic oxidation reactors operate in the range of 700 to 1,100 degrees F, which due to the use of the catalyst, is significantly lower than the minimum 1,500 degrees F that is required for thermal oxidation.

In order to operate within the required temperature range, the oxidation catalyst would need to be located either before the baghouse, where the exhaust gas is closer to the proper temperature but would still require supplemental heating, or after the baghouse, where the exhaust gas would need significant reheating to reach the required temperature. Because of the heavy PM loading in the exhaust gas, an oxidation catalyst located prior to the baghouse (and thus prior to removal of the PM) would quickly be fouled by the PM and the oxidation of CO would be greatly reduced. Although oxidation catalysts used in other applications, such as on natural gas combustion turbines, last on average for approximately five years before being replaced, Carmeuse estimates that if placed before the baghouse, the catalyst would foul within a few weeks. This renders the use of an oxidation catalyst prior to the baghouse to be technically and/or economically infeasible.

The catalyst fouling issue is resolved if the oxidation catalyst is located after the PM is removed by the baghouse. However, such placement would require reheating the exhaust gas stream up to the required operating temperature for the catalyst (at least 700 degrees F). Carmeuse performed a simplified cost analysis for locating an oxidation catalyst after the baghouse. Considering only annual costs for the natural gas to reheat the exhaust gas stream (excluding capital and construction costs to install the oxidation catalyst, non-fuel operational costs, and maintenance costs), Carmeuse estimates the cost of this control option to be approximately \$10,200/ton of CO eliminated (See Table D-1.2 in the application). Carmeuse asserts that this cost renders an oxidation catalyst economically infeasible. However, Carmeuse assumed a very low 50% destruction efficiency for CO in its cost estimate. DEQ recalculated the cost effectiveness of this control option using a 90% destruction efficiency, which yields a cost of \$5,675/ton of CO eliminated. Note that these cost estimates include only the cost of natural gas for reheating; they do not include capital costs for any equipment. DEQ agrees that an oxidation catalyst located after the baghouse is economically infeasible for CO control, even at the lower estimated cost.

Moreover, based on its absence from the RBLC, it appears that catalytic oxidation has not yet been demonstrated on a lime kiln.

(3) Good Combustion Practices. Good combustion practices consist primarily of controlled fuel/air mixing, maintaining the proper combustion zone temperature, and providing adequate residence time. These practices can be used to minimize the formation of CO, and it is technically feasible to implement them on the proposed vertical lime kilns.

A review of the fifteen lime kilns in the RBLC shows that none of those permits required a tailpipe control for CO such as an oxidation catalyst or thermal oxidation. Instead, each of these examples, including both vertical lime kilns, relied upon good combustion practices as BACT for CO. Accordingly, Carmeuse asserts that BACT for CO should be the use of good combustion practices. Carmeuse acknowledges that good combustion practices are economically feasible, so it did not provide an economic analysis of this control option.

CO BACT determination: DEQ determines that BACT for CO for the proposed vertical lime kilns is the use of good combustion practices. The CO emission limit for the Chemical Lime facility is 3.5 lb CO per ton of lime produced.⁷ Carmeuse has proposed a lower limit of 3.0 lb/ton based on the design data for its proposed kilns. The emission limit for CO established as BACT in the permit is 3.0 lb/ton of lime produced when burning solid fuel (coal or petcoke). A lower limit of 1.31 lb/ton of lime produced applies when burning natural gas. Compliance shall be determined through periodic stack testing using approved methods.

Nitrogen Oxides (NO_x) Control

Fuel burning within the vertical kilns is the primary source of NO_x emissions from the proposed project. NO_x is primarily formed from the oxidation of nitrogen that is present in combustion air during the combustion process. Temperature is the dominant factor in the amount of NO_x produced – higher temperatures result in more NO_x formation. As described previously, the maximum temperature in a vertical kiln is about 1,900 degrees Fahrenheit, as compared to 2,000 to 2,200 degrees in a rotary kiln. Therefore,

⁷ The Pennsylvania facility has a much lower CO limit at 0.3 lb/ton of lime, but this is because the facility is permitted to use only natural gas as a fuel.

vertical kilns inherently produce less NO_x than rotary kilns due to their lower maximum temperature.

Twelve control technologies were identified by Carmeuse as being potentially available to reduce NO_x emissions from the kilns, which are listed below in roughly most-effective to least-effective order:

1. Selective Catalytic Reduction (SCR)
2. Selective Non-Catalytic Reduction (SNCR)
3. Non-Selective Non-Catalytic Reduction (NSNCR)
4. Catalytic Ceramic Filter Media (CCFM)
5. Oxidation/Reduction Scrubbing (ORS)
6. Low-NO_x Burners (LNB)
7. Mid-Kiln Firing (MKF)
8. Water or Steam Injection
9. Mixing Air Fans and Air Staging
10. Clean Fuels
11. Efficient Kiln Design
12. Good Combustion Practices

Carmeuse has proposed two of the least effective options – efficient kiln design and good combustion practices – as BACT. Accordingly, all of the options described above must be discussed to establish why they are not feasible for the proposed vertical lime kilns.

(1) Selective Catalytic Reduction. SCR involves the post-combustion destruction of NO_x from the flue gas with a catalytic reactor. In SCR, ammonia injected into the exhaust gas reacts with NO_x and oxygen in the presence of a catalyst to form nitrogen and water. The function of the catalyst is to effectively lower the activation energy (i.e., the temperature) of the NO_x decomposition reaction. SCR operates within the temperature range of approximately 500 to 800 degrees F. SCR can achieve greater than 90% reduction of NO_x.

SCR has been commonly used for many years to control NO_x emissions from electric utility boilers, industrial boilers, and gas turbines, and more recently it has been applied to stationary diesel engines, nonroad diesel engines (such as locomotives), and on-road diesel engines (trucks). Because it is a tailpipe control that has been demonstrated in a wide variety of industrial applications, SCR is technically feasible for the proposed vertical lime kilns

(although, based on its absence from the RBLC, it appears that SCR has not yet been applied to any lime kilns).

However, the dust loading in the flue gas from a lime kiln (whether the newer vertical design or the traditional rotary design) is much higher than any of the applications described above where SCR has been applied successfully. The high dust loading in the kiln exhaust would quickly foul the catalyst bed in a traditional SCR system. There are two potential options to address the high dust loading – the use of a high-dust SCR system as the first control device or placing a traditional SCR system after the baghouse.

High-dust SCR has been successfully demonstrated on multiple pulverized coal boilers (PCBs). However, there are two important distinguishing factors between the exhaust streams from PCBs and lime kilns. First, the particulate matter control device loading typical for a PCB is approximately 10 g/Nm^3 , whereas the dust loading for a lime kiln prior to a baghouse is almost an order of magnitude higher, generally in excess of 80 g/Nm^3 . Second, the dust from a lime kiln is primarily calcium oxide (CaO), which is known to deactivate conventional catalysts by its conversion to calcium sulfate (while there is little or no CaO in PCB exhaust). Furthermore, there is no record of high-dust SCR having ever been used to control a lime kiln. For these reasons, DEQ finds that high-dust SCR is technologically infeasible for the proposed vertical lime kilns.

The other SCR option is to locate a traditional SCR system after the the baghouse that removes most of the PM from the exhaust stream.. The location of SCR after the baghouse requires the use of auxiliary heating of the flue gas stream in order to reach the temperature range necessary for effective operation of the SCR.⁸ Carmeuse has conservatively estimated the cost for tailpipe SCR to be approximately \$9,950/ton of NO_x removed⁹, which far exceeds the control costs borne by other sources for NO_x control in attainment areas in Virginia.

⁸ Any reheating of the flue gas stream would result in the generation of additional products of combustion, including more NO_x.

⁹ This cost is conservative (i.e., low) because it includes only the reagent, the natural gas for reheating, and the annualized capital costs for the equipment. It excludes installation costs, electricity usage, catalyst replacement, maintenance, and personnel costs.

In its cost estimate, Carmeuse assumed 70% NO_x control (see Table D-2.1) even though in Table 6-2 Carmeuse states the control efficiency of SCR to be between 70% and 90%. DEQ recalculated the cost effectiveness at 90% control, but with the lower NO_x emissions based on the European standard, which yields about \$9,185/ton of NO_x removed. This cost still far exceeds the control costs borne by other sources for NO_x control in attainment areas in Virginia.

However, since the cost of the natural gas for reheating the flue gas stream to the required temperature for SCR is a significant portion of these cost estimates, DEQ asked Carmeuse to consider splitting that reheat cost between SCR for NO_x control and an oxidation catalyst for CO control. The second version of Table D.2-1 in the application (on page 5 of Appendix D) considers both control options simultaneously, with an average cost for both pollutants of \$10,171/ton of pollutant removed. However, Carmeuse's calculations assume only 50% CO removal and 50% NO_x removal. DEQ recalculated this estimate using 90% pollutant removal (as DEQ did for each pollutant individually above), which yields a cost of \$5,085/ton of each pollutant removed. This cost far exceeds the cost of any CO control required previously in Virginia, so an oxidation catalyst for CO control remains economically infeasible. Since the CO portion remains economically infeasible, then the cost-sharing is not available for SCR for NO_x control, so that cost remains \$9,185/ton as described above.

For the foregoing reasons, DEQ agrees that traditional SCR is economically infeasible for the vertical lime kilns.

(2) Selective Non-Catalytic Reduction. SNCR involves the injection of ammonia or urea into the flue gas stream to react with the NO_x to produce elemental nitrogen (N₂), carbon dioxide (CO₂), and water (H₂O). SNCR can achieve NO_x reductions of about 50%, and it has recently been demonstrated on a rotary lime kiln in Alabama.

Since it does not utilize a catalyst to facilitate the reduction of nitrogen, SNCR requires much higher temperatures than SCR. If applied in a lime kiln, temperatures on the order of 1600 to 2100 degrees F are required to enable the nitrogen reduction reaction without contaminating the lime product with the SNCR reagent. The only potential location for an SNCR system in a vertical lime kiln that meets this temperature requirement without potentially fouling the lime product is in the crossover channel between the

two vertical kilns. However, the crossover channel is relatively small and experiences rapidly fluctuating temperatures, which render it a technically infeasible location for installing SNCR.

SNCR is technically feasible after the baghouse because there is sufficient space and by reheating the flue gas stream, the required temperature could be maintained for the appropriate amount of time. However, since SNCR requires temperatures significantly higher than SCR, the cost for natural gas for reheating the flue gas for SNCR would far exceed the cost for reheating the flue gas for SCR, which has already been determined to be too expensive. Carmeuse estimates SNCR to cost over \$34,000 per ton of NO_x removed. DEQ agrees that SNCR is economically infeasible because it far exceeds the control costs borne by other sources for NO_x control in attainment areas in Virginia.

(3) Non-Selective Non-Catalytic Reduction. NSNCR is also known as “staged combustion air”, where three distinct burning zones are created. First, is the initial burn zone, where excess air leads to high temperature, oxidizing conditions where NO_x is created. Second, is the secondary burn zone, where additional fuel is injected to create an environment where NO_x is reduced to elemental nitrogen. Third, is the final burn zone, where air is added to re-establish oxidizing conditions to consume the remaining fuel and lower temperatures limit the formation of additional NO_x.

For the proposed vertical kilns, as described previously, the fuel is fed into the kilns through fuel lances that extend into the primary chamber, where the fuel immediately contacts the heated limestone rock and combusts. Because traditional burners are not used, the fuel and limestone are commingled throughout the kiln, and there is not a traditional combustion zone, it is not possible to establish the three distinct burning zones described above. The fuel lances are an integral part of the design of the vertical kilns that cannot be replaced by traditional burners. Moreover, there are no known applications of NSNCR to either rotary or vertical lime kilns. Therefore, NSNCR is not technically feasible for the proposed vertical lime kilns.

(4) Catalytic Ceramic Filter Media (CCFM). Ceramic filter media with embedded nano-sized catalysts have recently been introduced into the air pollution control field. CCFM can remove NO_x as well as PM and SO₂ (and this control technology is discussed again in the SO₂ BACT analysis below). The catalyst used for NO_x

removal is similar to that used in SCR except for its size. The micronized size of the catalyst particles allows the nitrogen reduction reaction to occur at somewhat lower temperatures than SCR: 350 to 700 degrees F for CCFM, as compared to 500 to 800 degrees F for SCR. As with SCR, NO_x removal via ceramic filter media requires the injection of urea or ammonia into the flue gas stream before it enters the ceramic filter media.

CCFM has not yet been implemented on any lime kilns. Although this new technology has been implemented only on waste incinerators and glass furnaces to date, Carmeuse has not demonstrated that CCFM is technically infeasible for its proposed vertical lime kilns. However, this control technology will cost approximately the same as SCR (which as described above is roughly \$10,000/ton) for the following reasons: (1) both technologies have the same urea requirements because the stoichiometry is the same; (2) natural gas usage may be somewhat lower since the operating temperature range is lower (but this is not certain because there is significant overlap in the operating temperature ranges); and (3) the ceramic filter media is subject to fouling and must be periodically replaced, while there is no corresponding expense for SCR. Since the cost for CCFM is roughly the same as for SCR at approximately \$10,000 per ton, DEQ agrees with Carmeuse that CCFM is economically infeasible when evaluated solely for NO_x control because it far exceeds the control costs borne by other sources for NO_x control in attainment areas in Virginia.

(5) Oxidation/Reduction Scrubbing. ORS involves the injection of ozone, ionized oxygen, or hydrogen peroxide to further oxidize NO_x to species that are more water soluble and are then removed by a wet scrubber. ORS is commonly used in the cement industry for wet kilns, where it has been incorporated into an existing or proposed wet scrubber. A wet scrubber is not proposed for the vertical lime kilns, and ORS does not appear to have been implemented on a lime kiln or any other dry kiln to date. For these reasons, ORS is considered technically infeasible for this project.

(6) Low-NO_x Burners. LNBs are multi-channel burners that create primary and secondary combustion zones. The primary combustion zone is fuel-rich and oxygen-deficient, which limits the formation of NO_x. The secondary combustion zone is oxygen-rich to ensure complete combustion, but at a lower temperature than the primary combustion zone in order to limit NO_x formation.

LNBS have been successfully implemented in at least 20 rotary lime kilns in the United States.

However, as described previously, the proposed vertical kilns do not use traditional fuel burners. Instead, they use 28 individual fuel lances that introduce the fuel into immediate contact with the limestone. The fuel lances are an integral part of the design of the vertical kilns that cannot be replaced by traditional burners. Therefore, LNBS are technically infeasible for the proposed vertical lime kilns.

(7) Mid-Kiln Firing. MKF is a form of staged combustion that involves the use of a secondary fuel delivery system that is located at the midpoint of the kiln. MKF utilizes lower combustion temperatures at the primary burner to limit NO_x formation and also creates reducing conditions at the secondary fuel injection point that destroys some of the NO_x created in the primary combustion zone. MKF has been successfully implemented on rotary lime kilns.

As described above, however, inherent in the vertical kiln design is a fuel delivery system consisting of 28 individual fuel lances that introduce fuel throughout the kiln into direct contact with the limestone feed. Vertical lime kilns lack the traditional primary burner that is used in rotary kilns, so it is incompatible with the design of the vertical kiln to employ a NO_x control strategy that manipulates combustion conditions at the primary burner and also adds a secondary burner system. Therefore, MKF is technically infeasible for the proposed vertical kilns.

(8) Water or Steam Injection. In various industrial applications, such as combustion turbines, water or steam is injected into the primary combustion zone to reduce combustion temperatures, which limits the formation of NO_x. As described above, the proposed vertical kilns do not use traditional burners and the fuel is combusted in direct contact with the limestone feed. The injection of water or steam into the fuel and limestone mixture would adversely affect the calcining process. Therefore, water or steam injection is technically infeasible for the proposed vertical kilns.

(9) Mixing Air Fans and Air Staging. Mixing air fans are used in certain applications to ensure proper mixing within the combustion chamber, which prevents gas stratification within the combustion chamber. Air staging involves manipulation of the oxygen content within the primary combustion zone (less oxygen) and secondary

combustion zone (more oxygen). As described above, the proposed vertical kilns do not use traditional burners and the fuel is combusted in direct contact with the limestone feed. The presence of the solid limestone in the combustion chamber would inhibit the proper operation of either mixing air fans or air staging. Therefore, both of these NO_x control options are technically infeasible for the proposed vertical kilns.

(10) Clean Fuels. It is generally recognized that natural gas results in less formation of NO_x than solid fuels such as coal and petcoke. In this specific application, however, the sulfur content of the fuel impacts the final lime product. Higher sulfur fuels (such as coal and petcoke) produce a lime with greater sulfur content, while lower sulfur fuels (such as natural gas) produce a lime with a much lower sulfur content that has food grade and metallurgical uses. Therefore, limiting the choice of fuels for the vertical lime kilns would limit the Company's operational flexibility (if natural gas becomes temporarily unavailable for any reason), increase its operating costs (natural gas usually costs more than coal or petcoke), and ultimately affect the lime product to be sold (by impacting the sulfur content of the lime), all of which would serve to redefine the source. A BACT option that redefines the source must be rejected.

To be conservative, Carmeuse nonetheless estimated the incremental cost of using solely natural gas instead of coal or petcoke. The Company estimates that the exclusive use of natural gas would cost approximately \$20,000 per ton of NO_x avoided. Accordingly, even if this fuel restriction could be considered as potential BACT, it would be economically infeasible because it far exceeds the control costs borne by other sources for NO_x control in attainment areas in Virginia.

(11) Efficient Kiln Design. As compared to the rotary lime kiln design that has been the industry standard throughout the U.S. for decades, the proposed vertical lime kilns have a far greater thermal efficiency. This results in 30 to 45 percent less fuel usage per ton of lime produced, and this lower fuel usage yields a corresponding reduction in the amount of NO_x that is formed per ton of lime produced. Moreover, as described above, the fuel is combusted in direct contact with the limestone feed, which results in lower combustion temperatures that result in the formation of less NO_x.

Proper kiln design is listed as BACT for NO_x in the RBLC for many rotary lime kilns and it is even more appropriate as BACT

for vertical lime kilns due to their inherent low-NO_x properties. Because Carmeuse defines its project as the vertical lime kilns, no cost analysis is necessary for this option as the potential BACT for NO_x. Carmeuse proposes efficient kiln design – specifically consisting of the use of vertical lime kilns – as part of the BACT determination for NO_x. DEQ agrees that proper kiln design is an element of NO_x BACT for this project.

(12) Good Combustion Practices. Good combustion practices include the feeding of fuels and air into the combustion chamber in the proper amounts and proportions; homogenization of fuels and limestone feed; the use of appropriate sensors and computer controls. Good combustion practices is listed as BACT for NO_x in the RBLC for many rotary lime kilns. Carmeuse proposes good combustion practices as part of the BACT determination for NO_x. DEQ agrees that good combustion practices is an element of NO_x BACT for this project.

NO_x BACT Determination: Among the twelve potential NO_x control options evaluated, only two are both technically and economically feasible: efficient kiln design and good combustion practices. DEQ's BACT determination for NO_x is the required use of an efficient kiln design – specifically the proposed vertical, dual chamber configuration – and good combustion practices. BACT includes a permitted emission rate of 46.95 lb NO_x per hour when burning solid fuel (coal or petcoke), which is equivalent to 2.13 lb/ton of lime produced.¹⁰ As described in section III.A. above, these values are based on the European standard of 350 mg/nm³. When burning natural gas, a lower limit of 22.83 lb/hr applies, which is equivalent to 1.04 lb/ton of lime produced. Compliance shall be demonstrated through periodic stack testing using approved methods.

Sulfur Dioxide (SO₂) Control

The lime manufacturing process results in the formation of SO₂ from two sources: the combustion of fuel that contains sulfur and from the presence of small amounts of sulfur within the limestone feed. Sulfur present within the kiln will be oxidized to SO₂ due to the high temperature and the presence of oxygen necessary for combustion.

¹⁰ By way of comparison, the NO_x emission limit for the vertical kiln in Texas is 75 lb/hr (the limit for the Pennsylvania vertical kiln is much lower (7.9 lb/hr) because it fires only natural gas).

Carmeuse identified seven control mechanisms or technologies to reduce SO₂ emissions from the proposed kilns:

1. Inherent Dry Scrubbing (95% - base case)
2. Wet Scrubbing (98%)
3. Semi-Wet Scrubbing (Spray Dry Absorber) (90%)
4. Dry Sorbent Injection (DSI) (90%)
5. Lower Sulfur Fuels (varies)
6. Increased Oxygen
7. Catalytic Ceramic Filter Media (CCFM)

(1) Inherent Dry Scrubbing. In all lime kilns, some of the sulfur present in the kiln is removed through chemical reactions that naturally occur within the kiln. Calcium present in the limestone feed and lime product reacts with sulfur (whether from the limestone or the fuel) and oxygen (which is necessary for combustion of the fuel) to form calcium sulfite (CaSO₃) and/or calcium sulfate (CaSO₄). Both of these compounds are solids that become entrained with the lime product and/or are removed from the flue gas stream by the fabric filter baghouse that is used to control particulate matter (PM/PM₁₀/PM_{2.5}) emissions from each kiln.

Carmeuse states that modern parallel flow regenerative lime kilns such as the proposed design achieve 95% removal of SO₂ through inherent dry scrubbing. Since this removal occurs naturally (or inherently) within the kiln during the lime production process, no add-on equipment is necessary and no additional expense is incurred (beyond the normal lime production expense). Therefore, inherent dry scrubbing is both technically feasible and economically feasible. Carmeuse suggests that 95% removal of SO₂ via inherent dry scrubbing is the base case against which all other options must be compared. In other words, the baseline for assessing the economic feasibility of all other SO₂ control options should be the 5% of the SO₂ that actually exits the kilns, as opposed to the 100% of the SO₂ that is theoretically present within the kilns because the inherent dry scrubbing cannot be removed or turned off. DEQ agrees with this position.

(2) Wet Scrubbing. A wet scrubber is a large reactor vessel that uses an alkaline reagent (generally a limestone or lime slurry) to oxidize SO₂ to a calcium sulfate sludge. The reagent is sprayed from nozzles near the top of the vessel and falls downward due to gravity. Exhaust gases enter the vessel from the bottom and exit at the top in order to maximize interaction between the reagent and the SO₂. The calcium sulfate sludge is removed from the

bottom of the vessel. Note that this is essentially the same process that will already occur within the proposed lime kilns due to the inherent dry scrubbing described above, except that wet scrubbing adds water to the lime/limestone reagent.

Wet scrubbers are commonly used to reduce SO₂ emissions from large sources of sulfur dioxide such as coal-fired boilers. They can achieve up to 98% removal of SO₂. This technology is readily available and has been demonstrated in the field, and there are no known technological limitations that would preclude its use on a lime kiln. Therefore, it is technically feasible to add a wet scrubber to the proposed lime kilns.

Using the inherent dry scrubbing as a baseline, the “uncontrolled” emissions of SO₂ from each kiln will be 102 tpy. Carmeuse provided cost calculations for wet scrubbing in Table D-8.1 of its application. Assuming 95% control of the 102 tpy of SO₂ emissions from each kiln, wet scrubbing is estimated to cost approximately \$10,000 per ton of SO₂ removed. This cost far exceeds the control costs borne by other sources for SO₂ control in Virginia. Consequently, wet scrubbing is economically infeasible for the proposed kilns.

(3) Semi-Wet Scrubbing (Spray Dry Absorber or Lime Spray Drying). A spray dry absorber also uses a large reactor vessel. A moist (i.e., semi-wet) sorbent – usually lime or calcium hydroxide – is injected into the reactor. Heat from the exhaust gases evaporates the water from the sorbent, and the sorbent’s solid surfaces react with the SO₂. Dry calcium sulfate is produced, which is removed from the exhaust gases by a baghouse.

Spray dry absorbers have been used in various industrial applications. This technology is readily available and has been demonstrated in the field, and there are no known technological limitations that would preclude its use on a lime kiln. Therefore, it is technically feasible to add a spray dry absorber to the proposed lime kilns.

Carmeuse provided cost calculations for a spray dry absorber in Table D-9.1 of its application. Assuming 90% control of the 102 tpy of SO₂ emissions from each kiln, a spray dry absorber is estimated to cost about \$10,900 per ton of SO₂ removed. This cost far exceeds the control costs borne by other sources for SO₂ control in Virginia. Consequently, a spray dry absorber is economically infeasible for the proposed kilns.

(4) Dry Sorbent Injection (DSI). A dry sorbent injection (DSI) system directly injects a fine powder of dry sorbent into the flue gas stream. Hydrated lime is a commonly used sorbent. This alkaline sorbent readily reacts with acid gases such as H_2SO_4 , HCl , and HF . By optimizing the injection temperature and moisture content, DSI can also effectively remove SO_2 as well. The dry reaction products are removed by a particulate matter collector (which is the baghouse for the proposed lime kilns).

DSI has been used in various industrial applications since the late 1980s. This technology is readily available and has been demonstrated in the field, and there are no known technological limitations that would preclude its use on a lime kiln. Therefore, it is technically feasible to add a spray dry absorber to the proposed lime kilns.

Carmeuse and DEQ have not been able to identify an application of DSI to a lime kiln. Because the temperature profiles for vertical lime kiln exhaust are different than for utility and industrial boilers, it is not known what level of SO_2 control could be achieved if DSI was to be applied to the proposed kilns. However, even aggressively assuming 90% SO_2 removal, Carmeuse calculates that DSI would cost approximately \$7,500 per ton of SO_2 removed (and a more conservative estimate of 50% removal yields a cost of \$13,500/ton). This cost far exceeds the control costs borne by other sources for SO_2 control in Virginia. Consequently, a DSI is economically infeasible for the proposed kilns, even under the best-case assumption described above.

(5) Lower Sulfur Fuels. As described previously, the sulfur that is oxidized to SO_2 in a lime kiln comes from both the limestone feed and the fuel that is combusted in the kiln. By reducing the sulfur content of the fuel(s) used in a kiln, SO_2 emissions will be reduced as well (although not necessarily linearly). Since natural gas has a very low sulfur content, only coal and petcoke are evaluated here.

Coal: Carmeuse has requested authorization to burn coal with a sulfur content of up to 3.0%. However, the existing rotary lime kiln at the Winchester facility (which will be removed as part of the proposed project) is permitted to burn only 1.9% sulfur coal, and the rotary lime kiln at Carmeuse's Strasburg, Virginia facility is permitted to burn coal with only 1.0% sulfur. Carmeuse asserts that while the burners in these two rotary kilns can handle the lower sulfur coals, the fuel lances in the proposed vertical kilns

would be frequently plugged by the same fuel because the lower sulfur coal has a high free swelling index (FSI).

As described previously, the proposed vertical lime kilns have a fundamentally different design from traditional rotary lime kilns. A rotary kiln has a large, mostly open combustion chamber, and fuel is delivered by traditional burners and the fuel is combusted over the limestone feed. In contrast, in a vertical kiln the fuel and limestone are intermixed and fuel is delivered by 28 fuel lances spaced throughout the kiln. The European experience, where vertical lime kilns are common, has been that solid fuel with an FSI greater than 1.5 can plug the fuel lances, which prevents fuel from entering the kiln through that lance. Although the physical and/or chemical processes that cause solid fuels with a higher FSI to plug fuel lances are not yet understood, the various vertical kiln manufacturers recommend an FSI limit of 1.5, and to Carmeuse's knowledge, the European lime industry complies with this recommendation. By way of comparison, low-sulfur, bituminous coal from the eastern U.S. typically has a FSI of about 7.0, while the FSI of petcoke is typically around 1.0.

In fact, no Eastern coals have the requisite FSI regardless of their sulfur content. Instead, Carmeuse will need to obtain coal with the requisite FSI from Colorado, which is the only known source of coal in the U.S. with the necessary FSI. While this coal generally has a low sulfur content – typically less than 1% - there is variability between mines and even between coal seams within the same mine, with some sources approaching 3% sulfur content. Accordingly, Carmeuse has requested a 3% coal sulfur content limit. Based on the limited availability of coal with the requisite FSI in the U.S., DEQ agrees that it is technically infeasible to mandate the use of coal with less than 3% sulfur. However, based on historic data for this Colorado coal, both DEQ and Carmeuse expect that coal shipments will usually be closer to 1% sulfur than to 3% sulfur.

Petcoke: Petroleum coke is a bottom product of the petroleum refining process. The sulfur content of petcoke is dependent on the sulfur content of the crude oil being refined. Since the crude oil content usually varies over some range, petcoke sulfur content from a given refinery is usually expressed as a range. Petcoke that is readily available to Carmeuse will have between 5 and 7 percent sulfur.

One reliable source of lower sulfur petcoke was known – a refinery located in Bakersfield, California. This petcoke consistently contained less than 4% sulfur. However, that refinery is currently idled, and it is not known when – or if – the refinery will resume operations. Consequently, since lower sulfur petcoke is currently unavailable, it is technically infeasible for the proposed kilns.

(6) Increased Oxygen. Increasing oxygen levels in the kilns would convert SO_2 to SO_3 , which in turn reacts with the lime being produced in the kiln to yield CaSO_4 . The solid calcium sulfate is then incorporated into the lime product. Calcium sulfate is an impurity in the lime that many customers do not want. Therefore, increased oxygen is technically infeasible for lime kilns because it degrades the quality of the product. In addition, increasing oxygen levels in the kilns would have an adverse environmental impact by increasing the formation of NO_x .

(7) Catalytic Ceramic Filter Media (CCFM). Ceramic filter media with embedded nano-sized catalysts have recently been introduced into the air pollution control field. This catalytic ceramic filter media can remove SO_2 , NO_x , and PM. CCFM has not yet been implemented on any lime kilns. Although this newer technology has been implemented only on waste incinerators and glass furnaces to date, Carmeuse has not demonstrated that catalytic ceramic filter media is technically infeasible for its proposed vertical lime kilns.

With CCFM, SO_2 control is achieved via sorbent injection prior to the filters. This is essentially the same mechanism as DSI, so the cost for SO_2 removal via CCFM will also be roughly the same. As discussed in option 4 above, DSI has been determined to be economically infeasible; therefore, CCFM is similarly economically infeasible for SO_2 removal.

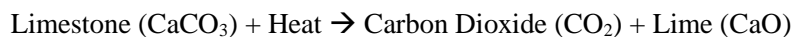
Since CCFM can also remove NO_x and PM, DEQ requested Carmeuse to assess the costs of removing all three pollutants via CCFM. Because the kilns will be equipped with baghouses, for $\text{PM}_{2.5}$ control, and the baghouses will remove 99.9% of the $\text{PM}_{2.5}$, it is assumed that no significant additional $\text{PM}_{2.5}$ would be removed via CCFM. To achieve NO_x control via CCFM, the exhaust gas would require reheating to reach the temperature required for catalytic oxidation of NO_x . Based solely on the cost of natural gas for reheating – and not accounting for the costs of ammonia or catalyst replacement – Carmeuse estimates that CCFM would cost at least \$16,000 per ton of SO_2 and NO_x removed.

This cost far exceeds the control costs borne by other sources for SO₂ or NO_x control in Virginia. Consequently, CCFM is economically infeasible for the proposed kilns even when considering its control of both pollutants.

SO₂ BACT determination: Seven different options/control technologies for SO₂ removal have been considered. The inherent dry scrubbing that naturally occurs during the lime production process – which cannot be turned off or removed – will eliminate approximately 95% of the SO₂ emissions from the kilns. Largely because only 5% of the SO₂ remains in the exhaust stream, all of the other control options considered are economically infeasible. DEQ’s BACT determination for SO₂ is 95% removal via inherent dry scrubbing. BACT includes a permitted emission rate of 28.60 lb SO₂ per hour when burning solid fuel (coal or petcoke), which is equivalent to 1.30 lb/ton of lime produced.¹¹ When burning natural gas, a much lower limit of 1.32 lb/hr applies, which is equivalent to 0.06 lb/ton of lime produced. Compliance will be monitored through the use of a CEMS for SO₂ and through the annual stack testing requirements established in the permit using approved methods.

GHG Control - CO₂

Carbon dioxide is a greenhouse gas (GHG) that is generated by the kilns from both the combustion of fuels and from the calcination process. Because of the additional generation of CO₂ from the conversion of limestone into lime, lime kilns generate more CO₂ per unit of fuel consumed as compared to other processes that utilize solid fuels such as coal and petcoke:



Carmeuse included CO₂ in its BACT analysis for GHG. Carmeuse identified the following four potential control technologies or strategies for CO₂:

1. Carbon capture and storage (CCS);
2. Low carbon fuel;
3. Efficient kiln design technology; and

¹¹ By way of comparison, the SO₂ emission limit for the Pennsylvania vertical kiln is moderately lower at 23.0 lb/hr and 0.8 lb/ton of lime; however, this kiln is permitted to fire only natural gas. For unknown reasons, EPA’s RBLC does not provide SO₂ emission limits for Chemical Lime’s vertical kiln in Texas.

4. Efficiency improvement strategies.

(1) Carbon Capture and Storage: CCS involves the separation and capture of CO₂ emissions from the flue gas; pressurization and perhaps short-term storage of the CO₂; transportation of the CO₂ via pipeline; and an end-use or ultimate disposal option (such as injection into underground reservoirs). Carmeuse determined that CCS is technically infeasible for the vertical kilns for two reasons. First, CO₂ is present in the flue gas at atmospheric pressure and low concentration, which means that a high volume of flue gas needs to be treated relative to the amount of CO₂ available. Moreover, substantial energy would be required to compress the CO₂ for transport and to generate steam to regenerate the capture solvent, which would result in increased CO₂ emissions at the power source (whether onsite or at an electric utility). Second, there are neither CO₂ pipelines, end-users, nor geologic storage formations within a reasonable distance from the Winchester facility. In addition, Carmeuse notes that CCS has not been implemented on a lime kiln or similar facility to date. For these reasons, Carmeuse contends that CCS is technically infeasible for its proposed project.

However, in the event that it was determined by DEQ or EPA that CCS is technically feasible for its proposed project, Carmeuse also conducted an economic analysis of CCS. One of the technical limitations cited by Carmeuse is the lack of a pipeline, end-user, or permanent storage option within a reasonable distance of the facility. This same issue can also be presented as an economic limitation, because a new CO₂ pipeline could be constructed by, or on behalf of, Carmeuse. The Company observes that the nearest existing CO₂ pipeline is located near Jackson, Mississippi, and Carmeuse conservatively estimates that it would cost at least \$430 million to construct a new pipeline to connect with that one. With the maximum captured CO₂ estimated to be approximately 327,705 tpy, this works out to about \$1,313 per ton. By way of comparison, in one recent case from North Dakota EPA agreed that a cost of approximately \$30/ton was not economically feasible for CCS. Carmeuse also states that this cost is “significantly higher” than the total cost of its proposed project. For these reasons, Carmeuse asserts that CCS is economically infeasible.

Based on the foregoing, DEQ agrees that CCS is economically infeasible for the proposed vertical lime kilns at Carmeuse’s Winchester facility.

(2) Lowest Carbon Fuel: Different fuels produce varying amounts of CO₂, with solid fuels such as coal/petcoke generally producing the most, and gaseous fuels such as natural gas generally producing the least. Therefore, requiring the use of natural gas in lieu of coal and petcoke would reduce CO₂ emissions.

Carmeuse has proposed the use of multiple fuels – coal/petcoke and natural gas – in order to provide flexibility for producing lime at the lowest cost possible in consideration of constantly changing energy markets and because the sulfur content affects the quality of the lime product and in some applications higher sulfur is desirable. Consequently, Carmeuse asserts that limiting the vertical kilns to only natural gas in order to reduce emissions would constitute an impermissible redefining of the source.

However, in the event that it was determined by DEQ or EPA that a fuel restriction could constitute BACT for its proposed project, Carmeuse provided an economic analysis of the use of natural gas as compared to coal/petcoke. The Company calculates that the cost of replacing coal/petcoke with natural gas is approximately \$80/ton of CO₂e. Carmeuse asserts that this cost renders this option economically infeasible even taking into account the superior fuel efficiency of the vertical kiln design.

DEQ agrees that BACT does not require Carmeuse to select one fuel over other available alternatives, given the company's intent to produce multiple grades of lime having different sulfur content. DEQ also agrees that the estimated cost of the fuel restriction of \$80/ton of CO₂e is economically infeasible. Accordingly, and for both reasons, DEQ rejects fuel restrictions as an element of BACT.

(3) Efficient Kiln Design: Carmeuse includes efficient kiln design as one element of its BACT analysis for CO₂. As compared to rotary lime kilns (such as the existing unit that is being replaced), vertical lime kilns have a higher thermal efficiency due to the dual chamber design and resulting preheating of the limestone by the exhaust gases from the other chamber. This higher thermal efficiency results in 30 to 45 percent lower fuel use, which reduces emissions of all products of combustion, including CO₂. Carmeuse asserts that efficient kiln design should be an element of the BACT determination for CO₂. No cost analysis was provided because the efficient kiln design is inherent in the proposed vertical kilns.

DEQ recognizes and agrees that the vertical kiln design is more efficient than the existing rotary kiln and therefore has lower CO₂

emissions on a unit of production basis. As described above, efficient kiln design has been an element of the NO_x BACT determination for several lime kilns, and is also part of the NO_x BACT determination for this project. As CO₂ BACT determinations become more frequent, DEQ expects that efficient kiln design will be a common element of CO₂ BACT determinations.

Accordingly, DEQ agrees that efficient kiln design is an element of the BACT determination for CO₂.

(4) Energy Efficiency Improvements: The last potential BACT element identified by Carmeuse is the implementation of various energy efficiency measures with the kilns. Any action that increases the energy efficiency of the kilns will reduce the amount of fuel used in the kilns, which will reduce CO₂ emissions.

Carmeuse identified the following energy efficiency measures that can be implemented with its proposed vertical kilns:

- Routine inspection and maintenance of the kilns and auxiliary equipment in accordance with the manufacturer's recommendations;
- Appropriate instrumentation and control devices to monitor and control the combustion process (combustion and cooling air is metered into the process in exact amounts with positive displacement blowers; fuel and stone are also metered in precise amounts into the kiln through weigh vessels; and a computer controls each combustion cycle exactly);
- Maximize insulation of the kilns to minimize heat loss; and
- Flue gas heat recovery by routing exhaust gases from the active chamber through the adjacent chamber to preheat the limestone.

Carmeuse proposes to implement all four of these strategies as BACT for CO₂. Carmeuse accepts that these strategies are economically feasible; therefore, it did not provide a cost analysis of these strategies. Compliance with these four strategies will be demonstrated through recording of operating conditions, inspections, and kiln design.

DEQ agrees that the four energy efficiency measures identified by Carmeuse constitute the other element of BACT for CO₂.

GHG Control – Methane

Methane (CH₄) is a product of combustion of the solid fuels used for the vertical kilns, and it is a potent greenhouse gas. Methane is present in the flue gas in significant concentrations only when incomplete combustion is occurring. In addition, when natural gas – which consists primarily of methane – is used, the presence of significant methane concentrations in the flue gas can also indicate that excess fuel is being provided to the kilns.

In light of the low concentrations of methane that are expected from the kilns, there are only two control techniques available to minimize methane emissions. One is to enhance the energy efficiency of the kilns in order to reduce the amount of fuel used per unit of lime produced. The other is to employ good combustion practices to ensure that complete combustion occurs within the kilns.¹²

As described above, five energy efficiency measures are being required in order to reduce the generation of fuel-based CO₂. These same measures will also serve to limit methane formation by reducing the amount of fuel consumed. Also as described above, various measures are being required to ensure complete combustion in order to minimize the formation of CO. These same measures will also serve to limit methane emissions by ensuring that nearly all methane present is combusted (oxidized). Accordingly, BACT for methane consists of the energy efficiency measures that are required as BACT for CO₂, and the good combustion practices that are required as BACT for CO.

GHG Control – N₂O

Nitrous oxide (N₂O) is a product of combustion of the fuels used for the vertical kilns, and it is a potent greenhouse gas. N₂O is present in the flue gas in significant concentrations only when incomplete combustion is occurring.

The two control strategies available for methane – energy efficiency measures and good combustion practices – are also

¹² The addition of a secondary combustion chamber, afterburner, or flare would also reduce methane emissions, but these control strategies are employed only for much higher methane concentrations than are expected from the vertical kilns. Moreover, the fuel required for any of these options would produce additional GHG emissions exceeding the amount of methane that would be eliminated.

available for N₂O. While N₂O catalysts are used at nitric acid production plants, the N₂O concentrations are much higher in that industry. The N₂O catalysts would not operate effectively at the very low N₂O concentrations expected in the vertical kiln flue gas (rendering this option technically infeasible), and the catalyst system would not be cost effective at these very low concentrations (rendering this option economically infeasible as well).

Accordingly, BACT for N₂O consists of the energy efficiency measures that are required as BACT for CO₂, and the good combustion practices that are required as BACT for CO.

GHG Control - Overall

Based on the foregoing BACT determinations for the three individual GHGs, the permit includes two conditions that limit GHG emissions from the vertical kilns. Condition 27 establishes an annual emission limit for all GHGs emitted from the kilns of 361,982 tpy, expressed as carbon dioxide equivalents (CO₂e). Condition 28 establishes a fuel usage limitation of 3.65 MMBtu (HHV) of fuel per ton of lime produced.

Startup & Shutdown Emissions – All Pollutants

Due to their highly effective insulation and pressurized state, the proposed vertical lime kilns can be maintained at or close to their operating temperature for several days with little or no fuel firing. Consequently, these kilns will not experience traditional shutdown and startup conditions whenever there is a short-term suspension of lime production. Instead, traditional shutdown and startup conditions will occur only when the kilns are taken offline for significant maintenance. Carmeuse conservatively estimates that this will occur only once per year, and last for no more than eight days.

During cold starts, Carmeuse proposes that natural gas will be used until the kilns are brought up to their proper operating temperature, at which time coal/petcoke may be used (or natural gas use can continue). The baghouse will operate during startup and shutdown conditions, and its effectiveness is not dependent on temperature or any other conditions that may be different during startup/shutdown as compared to normal operations. Moreover, as described above, no other add-on controls are required for the kilns, so there is no other pollution control equipment that could be affected by startup/shutdown conditions.

When calculating annual emissions for this project, Carmeuse assumed 357 days of operation at maximum capacity firing coal/petcoke (the worst-case fuel), with the remaining eight days of the year burning natural gas during startup/shutdown conditions (although in reality little or no fuel will be fired during the shutdown portion of this time).

DEQ agrees that Carmeuse properly addressed startup and shutdown conditions in its emissions calculations for these emission units. DEQ agrees with Carmeuse's proposal that BACT for cold start conditions is the use of only natural gas as a fuel until the kilns reach their normal operating temperature, which is required by Condition 21. The short-term emission limits based on natural gas firing that are specified in Condition 25 shall apply during cold starts.

Diesel Emergency Generator

The proposed new 200-hp diesel-fired emergency generator (manufactured in 2012 or 2013) is classified as new emergency compression ignition (CI) engine under federal regulations. The new emergency generator will be operated only during interruptions in the normal electrical power supply to the facility and for maintenance, testing, and operator training. When the normal electric supply is not available, the emergency generator will operate ancillary equipment to maintain safety of the system and personnel.

The new engine is subject to NSPS Subpart IIII and MACT Subpart ZZZZ. The emissions calculations for the generators are based on those applicable emission limits.

Emission limits apply for NO_x (along with nonmethane hydrocarbons), CO, and PM. There is no emission limit for SO₂ because the fuel sulfur content limit of 15 ppm (per 40 CFR 60.4027(b) and 40 CFR 80.510(b)) effectively limits SO₂ emissions to extremely low levels.

The emergency generator is limited to 100 hours per year for testing and maintenance under the federal regulations, and to no more than 500 hours of total operation per year by DEQ requirements for emergency generators. Emissions calculations for the emergency generator are based on 500 hours of operation per year, but actual usage – and therefore emissions – is expected to be far less than that.

Carmeuse proposes that the NSPS/MACT standards described above constitute BACT for the emergency generator that it proposes to add to the facility. In light of the limited operation of the emergency generator (no more than 500 hours per year, but usually significantly less), DEQ agrees that the applicable NSPS/MACT standards constitute BACT for this unit.

Solid Fuel Dryer

The proposed project includes a small heater to dry the solid fuels prior to milling. This unit has a heat input rating of 3.5 MMBtu/hr and will fire only natural gas. Emissions from the dryer, including the flue gas from combustion, will be routed to a dedicated baghouse to control PM.

Fuel-burning units firing natural gas with a heat input rating less than or equal to 50 MMBtu/hr are exempt from DEQ's minor NSR permitting regulations per 9 VAC 5-80-1320 B.1.d. The proposed dryer is well below this permitting threshold and its maximum emissions are very low: 1.25 tpy CO and 0.75 tpy NOx. However, this unit is subject to PSD permitting.

Carmeuse proposes BACT to consist of limiting the approved fuel to natural gas and the use of good combustion practices. In light of the small size and limited emissions from this unit, DEQ agrees that BACT for this unit consists of the suggested fuel limitation, good combustion practices, and the use of a dedicated baghouse to control PM/PM-10/PM-2.5.

Materials Processing and Handling Equipment

The proposed project includes numerous new and modified materials processing and handling emission units that will produce PM/PM-10/PM-2.5 emissions. These units consist of point sources such as crushers, screens, enclosed conveyors, enclosed transfer points, and storage bins, as well as fugitive sources such as storage piles, open conveyors, open transfer points, and roads. Emissions result from the processing and handling of the raw material (limestone), solid fuels (coal and petcoke), and the product (lime).

NSPS Subpart OOO applies to many of the proposed new and modified materials processing and handling emission units, which are listed in Table 4-1 in the application. (Subpart OOO also

applies to many of the existing materials processing and handling units that are not being modified.) The emission units subject to Subpart OOO (its “affected facilities”) are crushers, grinding mills, screening operations, bucket elevators, belt conveyors, storage bins, and enclosed loading stations.

Subpart OOO imposes an emission limit for PM/PM-10/PM-2.5 of 0.014 gr/dscf for all point sources and all other affected facilities that are fitted with an emissions capture system. Affected facilities that are fugitive sources are subject only to a 7% opacity limit, except for crushers, for which the limit is 12%. Subpart AAAAA, which applies to some of the same limestone materials processing and handling equipment covered by Subpart OOO, provides similar requirements.

For point sources, Carmeuse has proposed as BACT the use of fabric filters with emission limits of 0.010 gr/dscf for PM/PM-10 and 0.004 gr/dscf for PM-2.5. For fugitive sources, Carmeuse has proposed wet suppression and an opacity limit of 7% (12% for crushers). Since these controls meet or exceed Subpart OOO and Subpart AAAAA requirements and represent the state of the art for materials processing and handling emission units, DEQ agrees that these controls and emission limits constitute BACT for the materials processing and handling units.

Roadways

Unpaved roads can be a significant source of PM, PM-10, and PM-2.5 emissions. Paving of roadways is the most effective control available. Because the modeling results for PM-2.5 are very close to the NAAQS, Condition 92 of the permit requires that roads and operational areas of the facility that are subject to high lime product truck traffic be paved. At a minimum, all areas that were designated as paved in the PM2.5 modeling must be paved.

3. LAER

LAER applies only in nonattainment areas. Because the site of the proposed facility is attainment or unclassified for all pollutants, LAER does not apply. However, in accordance with the 1990 Draft PSD Workshop Manual, LAER technologies have been included as the most stringent technologies in the top-down BACT review.

4. NESHAP (40 CFR Part 61)

National Emission Standards for Hazardous Air Pollutants (NESHAP), found at 40 CFR 61, regulate emissions of specific HAPs from a limited number of source categories. 40 CFR 61 standards are incorporated by reference into Virginia Regulations at 9 VAC 5 Chapter 60, Part II, Article 1 (Rule 6-1). None of these Part 61 regulations apply to lime kilns or the other emissions units proposed by Carmeuse.

5. RACT

Reasonably Available Control Technology (RACT) standards apply only in nonattainment areas. Because the site of the proposed facility is attainment or unclassified for all pollutants, RACT does not apply.

6. MACT (40 CFR Part 63)

Maximum Achievable Control Technology (MACT) standards, found at 40 CFR 63, designate emission standards for HAPs from specific source categories. 40 CFR 63 standards are incorporated by reference into Virginia Regulations at 9 VAC 5 Chapter 60, Part II, Article 2 (Rule 6-2).

- *40 CFR 63 Subpart AAAAA, National Emissions Standards for HAPs for Lime Manufacturing Plants*

The Lime MACT was promulgated on January 5, 2004 and applies to lime manufacturing plants that are major sources for HAP. Per Table B.4-2 of the application, the PTE for the HAP hydrochloric acid (HCl) is 24.5 tpy, and for the HAP hydrofluoric acid (HF) is 3.1 tpy (for both kilns combined). Therefore, the potential HAP emissions from the proposed vertical kilns exceed both major source thresholds for HAPs, i.e., 10 tons per year of a single HAP (24.5 tpy of HCl) and 25 tons per year of all HAPs combined (27.6 tpy of HCl and HF (which does not include any HAP metals)). Accordingly, the proposed new vertical kilns and associated emission units are subject to the Lime Manufacturing Plant MACT.

The Lime MACT imposes an emission limit for PM of 0.10 lb PM per ton of feed to the kiln. (Note that PM is a more easily measured surrogate for the metal HAPs that are the subject of this regulation.) The Lime MACT also establishes PM and

visible emissions requirements for certain processed stone handling (PSH) that generally are consistent with the NSPS Subpart OOO requirements that are described below.

“Processed stone” is defined as limestone “that has been processed to a size suitable for feeding into a lime kiln.”

Subpart AAAAA does not include crushing activities, and begins with the first storage bin(s) or storage pile(s) containing limestone that is the proper size for feeding into the lime kiln. For this project, the last limestone crusher is roller crusher RC-110, and the subsequent storage piles are Pile3 and Pile4 (both of which are called Limestone Kilne Feed). Therefore, the PSH equipment that is subject to Subpart AAAAA begins with conveyor BC-320 (which draws limestone from Pile3 and Pile4) and ends with the Skip Hoists (Ref. Nos. SK-350 and -360), which feed the limestone into the kilns.

- *40 CFR 63 Subpart ZZZZ, National Emissions Standards for HAPs for Stationary Reciprocating Internal Combustion Engines (RICE)*

The RICE MACT was promulgated June 15, 2004 and applies to stationary reciprocating internal combustion (IC) engines located at major and area sources of HAP emissions. Per 40 CFR 63.6590(c), stationary IC engines subject to Regulations under 40 CFR Part 60 can meet the requirements of Subpart ZZZZ by meeting the requirements of 40 CFR 60 Subpart IIII for compression ignition engines. As mentioned below, 40 CFR 60 Subpart IIII applies to the proposed IC engine and the applicable requirements from Subpart IIII have been included in the permit. Therefore, no further requirements from Subpart ZZZZ apply to the diesel emergency generator.

7. NSPS (40 CFR Part 60)

New Source Performance Standards (NSPS), found at 40 CFR 60, designate emission standards for criteria pollutants (a few regulate HAPs as well) from new emissions units at specific source categories. 40 CFR 60 standards are incorporated into Virginia Regulations at 9 VAC 5 Chapter 50, Part II, Article 5 (Rule 5-5).

There are NSPS that apply to the materials handling operations and to the emergency generator, as detailed below:

- *40 CFR 60 Subpart OOO (Standards of Performance for Nonmetallic Mineral Processing Plants)*

Subpart 000 applies to various materials processing and handling operations at nonmetallic mineral processing plants, such as crushers, grinding mills, screens, bucket elevators, belt conveyors, storage bins, and certain loading and unloading activities. Limestone is included in the definition of “nonmetallic mineral” set forth in 40 CFR 60.671. Much of the existing limestone processing and handling equipment at the facility is already subject to Subpart 000, and much of the proposed new and modified limestone processing and handling equipment is also subject to Subpart 000. Table 4-1 in the application describes the 33 pieces of equipment (referred to as “affected facilities” in the regulation) that are subject to Subpart 000.

Affected facilities that emit through a stack are subject to a PM emission limit of 0.014 gr/dscf. There are no opacity/visible emission limits for these affected facilities. Fabric filters are subject to various monitoring requirements, including quarterly 30-minute visible emissions inspections using EPA Method 22. Affected facilities that have fugitive emissions are subject to an opacity limit of 7 percent (12 percent for crushers).

- *40 CFR 60 Subpart IIII (Standards of Performance for Stationary Compression Ignition Internal Combustion Engines)*

Subpart IIII applies to stationary internal combustion (IC) engines with a displacement of less than 30 liters per cylinder where the model year is 2007 or later. The rule imposes emission standards on NO_x, CO, and PM emissions based on the engine model year and engine use (emergency, fire pump, etc.). The subpart also requires engine owners and operators to use ultra-low sulfur fuel in the generators (distillate oil having no more than 0.0015% sulfur by weight). The applicable requirements for the new generator have been incorporated into the permit.

Since the new generator will meet the requirements of Subpart IIII, this unit does not have any further requirements under 40 CFR 63 Subpart ZZZZ (see above).

- *40 CFR 60 Subpart HH (Standards of Performance for Lime Manufacturing Plants)* is not applicable to the proposed vertical kilns because this regulation applies only to rotary lime kilns, per 40 CFR 60.340(a).

- *40 CFR 60 Subpart Kb (Standards of Performance for Volatile Organic Liquid Storage Vessels)* is not applicable to the 354-gallon diesel fuel storage tank that is incorporated into the base of the emergency electric generator unit (EG-2). Subpart Kb applies only to storage vessels having a capacity of at least 10,566.88 gallons (40 m³).
- *40 CFR 60 Subpart Y (Coal Preparation and Processing Plants)* is not applicable to the proposed coal/petcoke handling operations. Per 40 CFR 60.250(a), Subpart Y applies to coal preparation and processing plants that process more than 200 tons of coal per day. Condition 60 of the draft permit limits coal/petcoke throughput to 168 tons per day (and 52,560 tons per year), which avoids Subpart Y applicability.

8. State BACT (9 VAC 5-50-260)

Since PSD permitting is not triggered for VOC or SAM (see Table 7 above), emissions of these pollutants are not subject to the federal top-down BACT analysis. However, both pollutants are subject to the state BACT requirements provided in 9 VAC 5-50-260. The only appreciable sources of VOC and SAM are the two proposed vertical lime kilns.

Vertical Lime Kilns – Volatile Organic Compounds (VOC)

VOC emissions from this project are relatively low, at just 13.0 tpy from each vertical kiln and 26.4 tpy for all fuel-burning units (both kilns, the solid fuel dryer, and the emergency generator). The primary add-on control technology for VOC is thermal oxidation (also known as incineration). This control technology was evaluated above in the top-down PSD BACT analysis for carbon monoxide, and it has been determined to be economically infeasible with a cost of approximately \$12,000/ton to control 482 tpy of CO. Since the emissions of VOC are much lower than CO, the cost per ton to apply thermal oxidation to control VOC would be much higher, and therefore also economically infeasible.

The only other control strategy available for VOC in this application is the use of good combustion practices. Good combustion practices consist primarily of controlled fuel/air mixing, maintaining the proper combustion zone temperature, and providing adequate residence time. These practices can be used to maximize the destruction of VOC within the kilns, and it is

technically feasible to implement them on the proposed vertical lime kilns. Good combustion practices are required for the control of CO, NO_x, and methane based on the BACT analyses described above for those pollutants. DEQ determines that good combustion practices constitute state BACT for VOC.

Vertical Lime Kilns – Sulfuric Acid Mist (SAM or H₂SO₄)

A portion of the sulfur dioxide that is present in the kilns is converted to SAM, which itself is a criteria pollutant. While for certain industries separate controls are appropriate for SAM, beyond what may be required for sulfur dioxide, DEQ is not aware of such controls being required for any lime kiln. Therefore, due to the low level of SAM emissions and the fact that sulfur dioxide and PM-2.5 are subject to PSD – and thus have undergone a top-down BACT analysis – DEQ determines that no additional controls or measures are required specifically for SAM in order to satisfy state BACT requirements.

9. State Toxics (9 VAC 5, Chapter 80, Article 7)

The two proposed vertical lime kilns are a significant source of toxic pollutants, primarily HCl and HF, as described in section III.B. above. However, the state air toxics regulations provided in Article 7 do not apply to the proposed vertical lime kilns because they are subject to federal air toxics regulations, specifically MACT Subpart AAAAA (as described in section IV.D.6 above).

V. Compliance Determination

A. Stack testing requirements

The permit requires initial performance testing (stack tests) for PM, PM-10, PM-2.5, NO_x, SO₂, and CO for both of the vertical kilns. Separate tests must be conducted when firing coal, petcoke, and natural gas, for a total of six initial compliance tests for each pollutant. These tests must be conducted within 60 days after each kiln achieves its maximum production rate burning each, and no later than 180 days after startup of burning each fuel in each kiln.

Subsequent performance tests will be required every year for each kiln when firing coal and when firing petcoke for a total of four separate tests, per Condition 34 of the permit. However, per Condition 35, whenever three consecutive stack tests are in compliance with the permitted emission limits (evaluated on a kiln-specific, fuel-specific, and pollutant-

specific basis), then testing for that pollutant from that kiln when firing that specific fuel will be required only once every five years.

B. Visible emissions evaluations

An initial visible emissions evaluation (VEE) is required concurrently with the initial performance testing for the two vertical kilns. Subsequently, additional VEEs on one or both vertical kilns must be conducted upon request by DEQ.

Initial VEEs are required for the various materials handling units that are subject to Subparts OOO or AAAAA, as specified in the permit. These tests must be conducted within 60 days after the facility achieves its maximum production rate, and no later than 180 days after startup of the facility. Subsequent performance tests will be required upon request by DEQ.

C. Fuel testing requirements

The permit requires Carmeuse to obtain a certification from the fuel supplier for each shipment of coal and of petcoke to be used in the vertical kilns that specifies the heating value, sulfur content, and other relevant characteristics of the fuel. The permit also requires Carmeuse to obtain a certification from the fuel supplier for each shipment of distillate oil to be used in the emergency generator that specifies the sulfur content and that the fuel meets ASTM standards for No. 2 diesel fuel.

D. Continuous Monitoring – COMS and CEMS

The permit requires the use of a continuous opacity monitoring system (COMS) for each vertical kiln because of the use of a control device to reduce PM emissions. Condition 7 of the permit requires the COMS to be operated in accordance with 40 CFR Part 63, Subpart A (MACT General Provisions) and Performance Specification 1 of Appendix B to 40 CFR Part 60. The permit requires the use of a continuous emissions monitoring system (CEMS) for sulfur dioxide for each vertical kiln that will confirm the amount of “inherent scrubbing” that occurs within the kilns. Moreover, Carmeuse’s rotary kiln at its Strasburg facility has shown significant changes in sulfur dioxide emissions over time, and that unit now has CEMS for SO₂ in accordance with the Best Available Retrofit Technology (BART) permit for that unit. Requirements for the CEMS are provided in Conditions 8 through 10 of the permit. CEMS are not required for NO_x or CO because there are no controls for these pollutants.

E. Post-construction ambient monitoring requirements

DEQ policy requires post-construction ambient monitoring whenever modeled concentrations of any criteria pollutant exceed 90% of the level of the applicable NAAQS. As described in section IV.C. above, Carmeuse's modeling shows a PM_{2.5} concentration of 11.99 ug/m³, as compared to the annual NAAQS of 12 ug/m³. This modeled concentration is 99.9% of the NAAQS. Consequently, Carmeuse must perform post-construction monitoring of PM_{2.5} to ensure that the NAAQS is not exceeded. The monitoring must be conducted for at least one year after normal operation of the vertical kilns is achieved. The post-construction monitoring requirements are specified in Condition 105 of the permit.

F. Recordkeeping requirements

The permit establishes extensive recordkeeping requirements in Conditions 106 (PSD) and 118 (minor NSR), which include:

- The monthly and annual production of lime;
- The hours of operation of each vertical kiln;
- The monthly and annual consumption of limestone;
- The annual throughput of lime;
- The monthly and annual throughput of fuels (coal, petcoke, natural gas, and distillate oil (diesel fuel));
- All fuel supplier certifications;
- COMS opacity data;
- CEMS sulfur dioxide data;
- Results of all performance tests and VEEs;
- Periodic visible emissions inspection results;
- Daily wet suppression spray systems results;
- Records related to startup, shutdown, and malfunction;
- Hours of operation of the emergency generator;
- A copy of the Dust Control Plan; and
- All records required by Subparts AAAAA and OOO.

The records must be available for DEQ inspection and maintained for five years.

VI. Public Participation

A. Applicant Informational Briefing

In accordance with Section 9 VAC 5-80-1775 C of the Regulations, the applicant held an informational briefing at 6:30 p.m. on June 26, 2012 at

the Ruritan Building in Clear Brook. The briefing was advertised in the Winchester Star on May 2, 2012, which was within 30 days of Carmeuse receiving DEQ's ILOD (as required by 9 VAC 5-80-1775A). The informational briefing was held 55 days after publication of the notice (as required by 9 VAC 5-80-1775C (which requires the briefing to be held at least 30 days but less than 60 days after publication of the notice)). Eight members of the public and two members of the media attended the applicant's informational briefing.

B. Public Briefing

9 VAC 5-80-1775 J specifies that a briefing be scheduled prior to the public comment period if appropriate. VRO has scheduled a public briefing at 6:00 p.m. on January 30, 2014 at the Ruritan Building in Clear Brook. The briefing requires a 30-day (at minimum) notification period. A legal advertisement for the briefing was published in the Winchester Star on December 26, 2013.

C. Public Hearing

In accordance with 9 VAC 5-80-1775 E, VRO will hold a public hearing to accept comments on the air quality impact of the proposed source, alternatives to the source, the control technology required, and other appropriate considerations. The public hearing is tentatively scheduled for March 11, 2014 at the Ruritan Building in Clear Brook. A legal advertisement for the hearing will be published in the Winchester Star newspaper at least 30 days prior to the public hearing

D. Documents Concerning Public Comment Period

The draft permit, engineering memorandum, Carmeuse's permit application, and modeling information, are available for review in three locations: (1) at DEQ's Valley Regional Office (VRO) in Harrisonburg; (2) at the Handley Library, which is located at 100 West Piccadilly Street in Winchester (this is the closest public library to the facility that is within Virginia); and (3) online on DEQ's website at: <http://www.deq.virginia.gov/Programs/Air/PublicNotices/AirPermits.aspx>. These documents will remain available for review throughout the public comment period.

E. Public Comment

Pursuant to 9 VAC 5-80-1775 F, the public comment period must run for 45 days, 15 days of which must be after the public hearing. The public

comment period is anticipated to run from January 31, 2014 through March 26, 2014. All comments received will be recorded, reviewed, and a Response to Comments document will be written.

VII. Notification of Other Government Agencies

A. Local Zoning

Because the proposed facility constitutes a major modification to an existing stationary source that is subject to air permitting regulations, a local governing body certification form is required in accordance with Department policy and § 10.1-1321.1 of the Code of Virginia. On March 2, 2012, the Zoning Administrator for Frederick County certified that the proposed facility is fully consistent with local ordinances by signing the local governing body certification form. This form was received by DEQ on March 7, 2012, and it is included as Attachment 1.

B. Environmental Protection Agency (EPA)

In accordance with 9 VAC 5-80-1765, there are specific notification requirements to advise EPA of sources impacting federal Class I areas. Accordingly, a copy of the permit application and DEQ's Initial Letter Of Determination were provided to EPA Region III on March 28, 2012. EPA was provided with a copy of the draft permit, draft engineering analysis, modeling analysis, and revised comprehensive application on January __, 2014, and will be notified of the public comment period and the final determination on permit issuance.

C. Federal Land Managers (FLM)

Because of the Winchester facility's proximity to SNP (see Table 1), a protected Class I area, DEQ has worked with the Federal Land Managers (FLMs) whose responsibility it is to oversee such areas. In accordance with the Memorandum of Understanding dated March 31, 1993, between DEQ and SNP and the Jefferson National Forest, both the National Park Service (NPS) and U.S. Forest Service (USFS) were provided copies of Carmeuse's permit application and supplemental addenda, most notably the Class I and Class II modeling analyses. Numerous conference calls were conducted between NPS, Carmeuse, and DEQ to determine an acceptable approach to the Class I air quality analyses, which are reviewed and assessed primarily by NPS. NPS was provided a copy of Carmeuse's Class I and Air Quality Related Values (AQRVs) analyses and its review is currently underway.

A copy of the permit application and DEQ's Initial Letter Of Determination (ILOD) were provided to the FLMS on March 28, 2012. In a letter dated December 26, 2013, DEQ provided notification that the application was considered complete and that the FLM 60-day review period had begun. According to 9 VAC 5-80-1765 B, this notification must be provided at least 60 days before the public hearing, which is tentatively scheduled for March 6, 2014. The 60-day letter also transmitted the current application, DEQ's modeling analysis, and the public notice for the public briefing to be held on January 30, 2014. The FLMS were also provided the draft permit and draft engineering analysis on December 31, 2013.

VIII. Pollution Prevention

Site-specific pollution prevention measures have been included as requirements in the permit, such as the following:

- The vertical configuration of the two proposed lime kilns is considered a pollution prevention alternative because this design uses less fuel per ton of lime produced than the traditional rotary kiln design. The dual-chamber design, with the use of exhaust gases from one chamber to preheat the limestone in the other chamber, contributes to the higher efficiency and reduced fuel usage. The reduced fuel usage directly results in the generation of fewer pollutants per ton of lime produced.
- The use of enclosures and underground conveyors prevents the introduction of PM, PM-10, and PM-2.5 into the ambient environment from those materials handling processes.
- The fabric filters significantly reduce the quantity of PM, PM-10, and PM-2.5 that is released to the ambient environment from various materials handling processes.
- The paving of certain roads that are currently unpaved will prevent certain PM, PM-10, and PM-2.5 emissions.

IX. Title V Operating Permit (9 VAC 5 Chapter 80, Article 1)

The existing facility already is required by Virginia regulations to obtain a federal operating permit under Title V of the Clean Air Act. The existing permit VRO80504 became effective on January 24, 2008, and it expired on January 23, 2013. Carmeuse submitted a Title V renewal application that DEQ determined was timely and complete via letter dated August 1, 2012. The Regulations require that Carmeuse submit a Title V permit modification application within 12 months of the commencement of operation of the new vertical lime kilns. Due to the pending issuance of this PSD permit and the need to subsequently modify the Title V permit, DEQ and Carmeuse agreed to allow the existing Title V permit to

expire and for Carmeuse to continue operating under the existing permit and the application shield until such time as it submits a revised Title V renewal application that incorporates this forthcoming PSD permit and DEQ issues the Title V permit renewal.

X. Acid Rain Operating Permit (9 VAC 5 Chapter 80, Article 3)

Carmeuse is not required by Virginia Regulations to obtain a permit under the federal Acid Rain program for the proposed modifications to the Winchester facility.

XI. NO_x and SO₂ Trading Programs (9 VAC 5 Chapter 140)

Virginia has established several emissions trading programs (NO_x Budget Trading Program, CAIR NO_x Annual Trading Program, CAIR NO_x Ozone Season Trading Program, and CAIR SO₂ Trading Program) to meet the requirements of EPA's budget trading programs. Carmeuse is not required by Virginia Regulations to include its Winchester facility in any of these trading programs due to the proposed modifications.

XII. Special Considerations

No other special considerations have been accounted for in this PSD permit.

XIII. Recommendation

Approval to proceed with public comment period is recommended.

Attachments

Attachment A: Local Governing Body Certification Form



Attachment B: DEQ AQA's "Technical Review of the Air Quality Analysis in Support of the PSD Application [for this project]" on December 10, 2013

Attachment C: Applicant's Emissions Calculations

ATTACHMENT A:

Local Governing Body Certification Form

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY - AIR PERMITS

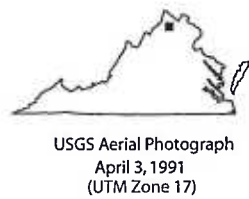
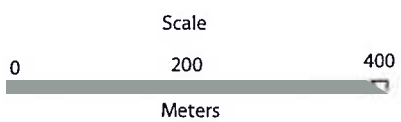
LOCAL GOVERNING BODY CERTIFICATION FORM	
Facility Name: Carmeuse Lime & Stone	Registration Number: 80504
Applicant's Name: Carmeuse Lime & Stone	Name of Contact Person at the site: David St. Clair
Applicant's Mailing address: P.O. Box 71 Strasburg, Virginia 22657	Contact Person Telephone Number: (540) 465-6801
Facility location (also attach map): Clear Brook, Virginia	
Facility type, and list of activities to be conducted: Limestone quarry, limestone products plant, and lime manufacturing facility	
<p>The applicant is in the process of completing an application for an air pollution control permit from the Virginia Department of Environmental Quality. In accordance with § 10.1-1321.1, Title 10.1, Code of Virginia (1950), as amended, before such a permit application can be considered complete, the applicant must obtain a certification from the governing body of the county, city or town in which the facility is to be located that the location and operation of the facility are consistent with all applicable ordinances adopted pursuant to Chapter 22 (§§ 15.2-2200 et seq.) of Title 15.2. The undersigned requests that an authorized representative of the local governing body sign the certification below.</p>	
Applicant's signature: 	Date: <u>2/29/12</u>
<p>The undersigned local government representative certifies to the consistency of the proposed location and operation of the facility described above with all applicable local ordinances adopted pursuant to Chapter 22 (§§15.2-2200 et seq.) of Title 15.2. of the Code of Virginia (1950) as amended, as follows:</p> <p>(Check one block)</p> <p><input checked="" type="checkbox"/> The proposed facility is fully consistent with all applicable local ordinances.</p> <p><input type="checkbox"/> The proposed facility is inconsistent with applicable local ordinances; see attached information.</p>	
Signature of authorized local government representative: 	Date: <u>2 MAR 12</u>
Type or print name: <u>MARK R CHELAW</u>	Title: <u>ZONING ADMINISTRATION</u>
County, city or town: <u>FREDERICK</u>	

[THE LOCAL GOVERNMENT REPRESENTATIVE SHOULD FORWARD THE SIGNED CERTIFICATION TO THE APPROPRIATE DEQ REGIONAL OFFICE AND SEND A COPY TO THE APPLICANT.]

To: _____
Date: _____



Edge markings in UTM coordinates (meters)



ATTACHMENT B:

DEQ AQA's "Technical Review of the Air Quality Analysis in Support of the PSD Application [for this project]", dated December 10, 2013



MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY *Office of Air Quality Assessments*

629 East Main Street, Richmond, VA 23219
8th Floor

804/698-4000

To: Janardan Pandey, Air Permit Manager (VRO)

From: Mike Kiss, Director - Office of Air Quality Assessments (AQA)

Date: December 10, 2013

Subject: Technical Review of the Air Quality Analyses in Support of the PSD Permit Application for the Proposed Modification to the Carmeuse Lime & Stone Facility in Clear Brook, Frederick County, Virginia

Copies: Bobby Lute

I. Project Background

Carmeuse Lime & Stone (Carmeuse) owns and operates a limestone quarry, limestone processing, and lime manufacturing plant in Clear Brook, Frederick County, Virginia, just east of Interstate 81, off Brucetown Road, northeast of the town of Winchester. The facility is referred to as the Winchester facility. Carmeuse is proposing to install two parallel flow regenerative kilns and remove the existing rotary lime kiln. The vertical kilns will be direct fired and use petroleum coke as the primary fuel. The kilns will also be capable of firing coal and natural gas. As part of the proposed project, Carmeuse is proposing to replace existing limestone and lime product material handling operations surrounding the lime plant. Additionally, one new natural gas-fired heater for the coal/coke mill and one new diesel-fired emergency generator will be installed.

The Winchester facility is a lime plant that emits, or has the potential to emit, 100 tons per year or more of a regulated pollutant and is an existing major stationary source under 9 VAC 5 Chapter 80, Article 8 (Prevention of Significant Deterioration (PSD)) of the Commonwealth of Virginia Regulations for the Control and Abatement of Air Pollution. The pollutants subject to PSD review are sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter having an aerodynamic diameter equal to or less than 10 microns (PM₁₀), particulate matter having an aerodynamic diameter equal to or less than 2.5 microns (PM_{2.5}), carbon monoxide (CO), and

greenhouse gases (GHG). As a result, PSD regulations require an air quality analysis be performed that demonstrates that the projected air emissions from the proposed modified facility will neither cause or significantly contribute to a violation of any applicable National Ambient Air Quality Standard (NAAQS) or PSD increment. In addition, PSD regulations require that an additional impact analysis consisting of a soil and vegetation analysis, a growth analysis, and a visibility impairment analysis be conducted.

An analysis of the project's impact on air quality and air quality related values (AQRVs) in any affected Class I area may also be required, contingent upon input from the Federal Land Managers (FLMs). Since Shenandoah National Park, a Class I area managed by the National Park Service (NPS), is within 50 kilometers (km) of the Winchester facility, an AQRV analysis was required for this Class I area. However, the United States Forest Service (USFS) and the United States Fish and Wildlife Service (FWS) each stated in an e-mail dated February 3, 2012 and February 6, 2012, respectively, that an AQRV analysis was not required for their respective managed Class I areas. The AQRV analysis is subject to review by the AQA and the appropriate FLM.

The following is a summary of the AQA's review of the required air quality analyses for the Winchester facility for both Class I and Class II PSD areas. The worst-case impacts from all operating scenarios considered, including startup and shutdown operations, are presented in this memorandum.

II. Modeling Methodology

The Class I and Class II air quality modeling analyses conform to 40 CFR Part 51, Appendix W - Guideline on Air Quality Models and were performed in accordance with their respective approved modeling methodology. The air quality model used for the far-field (greater than 50 km from the Winchester facility) Class I area analysis was the EPA-approved regulatory version of the CALPUFF modeling system (Version 5.8, Level 070623). The CALPUFF modeling system is the preferred model for long-range transport applications and is contained in Appendix W of 40 CFR Part 51. The air quality model used for the Class II and near-field (within 50 km of the Winchester facility) Class I area analyses was the most recent version of the AERMOD modeling system (Version 12345). The AERMOD modeling system is the preferred EPA-approved regulatory model for near-field applications and is also contained in Appendix W of 40 CFR Part 51.

Additional details on the modeling methodology can be found in Carmeuse's Class I and Class II modeling reports that were submitted by the applicant on September 25, 2013 and November 25, 2013, respectively.

III. Modeling Results

A. Class II Area - Preliminary Modeling Analysis

A preliminary modeling analysis for criteria pollutants was conducted in accordance with PSD regulations to predict the maximum ambient air impacts. The preliminary analysis modeled emissions from the proposed modified facility only to determine whether or not the impacts were above the applicable significant impact levels (SILs). For those pollutants for which maximum predicted impacts were less than the SIL, no further analyses was required (i.e., predicted maximum impacts less than SILs are considered insignificant and of no further concern). For impacts predicted to be equal to or greater than the SIL, a more refined air quality modeling analysis (i.e., full impact or cumulative impact analysis) is required to assess compliance with the NAAQS and PSD increment.

The worst-case emissions associated with all proposed operating scenarios were modeled, as well as startup/shutdown emissions. The specific emission rates and corresponding stack parameters that were modeled are consistent with the values contained in the permit application submitted by Carmeuse. Table 1 below shows the maximum predicted ambient air concentrations.

Table 1
Class II Preliminary Modeling Analysis Results vs. Significant Impact Levels

Pollutant	Averaging Period	Maximum Predicted Concentration From Proposed Modified Facility ($\mu\text{g}/\text{m}^3$)	Class II Significant Impact Level ($\mu\text{g}/\text{m}^3$)
SO ₂	1-hour	107.5	7.86
	3-hour	50.6	25
	24-hour	17.4	5
	Annual	1.53	1
NO ₂	1-hour	165.3	7.5
	Annual	2.41	1
PM ₁₀	24-hour	26.4	5
	Annual	2.28	1
CO	1-hour	276.6	2,000
	8-hour	63.3	500

The modeling results for CO (1-hour and 8-hour averaging periods) were less than the applicable SILs. Therefore, a full impact analysis for this pollutant and averaging periods was not required. Furthermore, the additional pollution from the proposed modified facility would not cause or contribute to a violation of any applicable NAAQS for this pollutant and averaging periods with impacts below the applicable SILs.

A full impact analysis for SO₂ (1-hour, 3-hour, 24-hour, and annual averaging periods), NO₂ (1-hour and annual averaging periods), and PM₁₀ (24-hour and annual averaging periods) was conducted because the preliminary modeling analysis results exceeded the applicable SILs. Additionally, a full impact analysis was conducted for PM_{2.5} (24-hour and annual averaging periods) because there are no applicable SILs for this pollutant.

B. Class II Area – Cumulative Impact Modeling Analysis

The cumulative impact analysis described below consisted of separate analyses to assess compliance with the NAAQS and Class II PSD increments for SO₂, NO₂, PM₁₀, and PM_{2.5} for the indicated averaging periods. It is important to note that the cumulative impact modeling results (both NAAQS and PSD increment) can sometimes be less than the “source only” modeling results in Table 1 of this memorandum. This is due to the fact that source only modeling uses the maximum concentration to determine significance, whereas the cumulative modeling results reflect the form of the air quality standard. For example, the following criteria must be met to attain the NAAQS:

- SO₂ (1-hour) - To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed the standard
- SO₂ (3-hour) - Not to be exceeded more than once per year
- SO₂ (24-hour) - Not to be exceeded more than once per year
- SO₂ (annual) - Never to be exceeded
- CO (1-hour and 8-hour) - Not to be exceeded more than once per year
- NO₂ (1-hour) - To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed the standard
- NO₂ (annual) - Never to exceed the standard
- PM₁₀ (24-hour) - Not to be exceeded more than once per year on average over 3 years
- PM_{2.5} (24-hour) - To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed the standard
- PM_{2.5} (annual) - To attain this standard, the 3-year average of the weighted annual mean PM_{2.5} concentrations from single or multiple community-oriented monitors must not exceed the standard

NAAQS Analysis

The NAAQS analysis included emissions from the proposed modified facility, emissions from existing sources from Virginia, West Virginia, and Maryland, and representative ambient background concentrations of SO₂, NO₂, PM₁₀, and PM_{2.5}. The results of the analysis are presented in Table 2 and demonstrate compliance with the applicable NAAQS.

Table 2
 NAAQS Modeling - Cumulative Impact Results

Pollutant	Averaging Period	Modeled Concentration From All Sources ($\mu\text{g}/\text{m}^3$)	Ambient Background Concentration ($\mu\text{g}/\text{m}^3$)	Total Concentration ($\mu\text{g}/\text{m}^3$)	NAAQS ($\mu\text{g}/\text{m}^3$)
SO ₂	1-hour	144.2	49.8	194.0	196.5
	3-hour	968.9	90.1	1,059.0	1,300
	24-hour	180.7	27.2	207.9	365
	Annual	2.26	5.9	8.18	80
NO ₂	1-hour	114.0	73.4	187.4	188
	Annual	3.41	18.8	22.21	100
PM ₁₀	24-hour	86.39	32.0	118.39	150
PM _{2.5}	24-hour	8.98	24.0	32.98	35
	Annual	1.77	10.2	11.97	12

PSD Increment Analysis

The PSD increment analysis included emissions from the proposed modified facility and emissions from increment-consuming sources from Virginia, West Virginia, and Maryland. Table 3 below presents the results of the analysis and shows that all concentrations were below their applicable PSD increment.

Table 3
 PSD Increment Modeling - Cumulative Impact Results

Pollutant	Averaging Period	Modeled Concentration From All Sources ($\mu\text{g}/\text{m}^3$)	Class II PSD Increment ($\mu\text{g}/\text{m}^3$)
SO ₂	3-hour	68.3	512
	24-hour	15.1	91
	Annual	1.90	20
NO ₂	Annual	2.87	25
PM ₁₀	24-hour	27.68	30
	Annual	3.16	17
PM _{2.5}	24-hour	6.55	9
	Annual	0.88	4

NAAQS and PSD Increment Analyses Conclusions

Based on DEQ's review of the NAAQS and PSD increment analyses, assuming DEQ's regional office processing the permit application approved all of the emission estimates and associated stack parameters for the modeled scenarios, the proposed modified Carmeuse Lime & Stone Winchester facility does not cause or significantly contribute to a predicted violation of any applicable NAAQS or Class II area PSD increment.

Toxics Analysis

The Winchester facility is not subject to the state toxics regulations at 9 VAC 5-60-300 et al. All emission sources of toxic pollutants will be regulated by a MACT Standard. Therefore, a toxic pollutant modeling analysis was not conducted.

Additional Impact Analysis

In accordance with the PSD regulations, additional impact analyses were performed to assess the impacts from the proposed modified facility on visibility, vegetation and soils, and the potential for and impact of secondary growth. These analyses are discussed below.

Visibility

Carmeuse has indicated that a Class II area visibility analysis was not necessary because there are no protected vistas near the Winchester facility. Also, the visibility in the area near the Winchester facility will be protected by operational requirements, such as air pollution controls, stringent limits on visible emissions, and fugitive dust controls that will be incorporated into its air permit. A Class I area visibility analysis was performed for Shenandoah National Park and is discussed in Section C of this memorandum (Class I Area Modeling Analysis).

Vegetation and Soils

An analysis on sensitive vegetation types with significant commercial or recreational value was conducted. The analysis compared maximum predicted concentrations from the proposed modified facility against the secondary NAAQS and a range of injury thresholds found in various peer-reviewed research articles as well as criteria contained in the EPA document *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils and Animals* (EPA, 1980). Table 4 shows the maximum predicted concentrations for SO₂, NO₂, PM₁₀, PM_{2.5}, and CO were all below the respective thresholds (i.e., the minimum reported levels at which damage or growth effects to vegetation may occur). As a result, no adverse impacts on vegetation are expected.

Table 4
 Comparison of Vegetation Sensitivity Thresholds to Maximum Modeled
 Concentrations from the Carmeuse Lime & Stone Winchester Facility

Pollutant	Averaging Period	Total Concentration ($\mu\text{g}/\text{m}^3$)	Sensitive Vegetation Threshold ($\mu\text{g}/\text{m}^3$)
SO ₂	1-hour	157.3	917
	3-hour	140.7	786
	Annual	7.45	18
NO ₂	1-hour	238.7	940
	4-hour ⁽¹⁾	238.7	3,760
	8-hour ⁽¹⁾	238.7	3,760
	1-month ⁽¹⁾	238.7	564
	Annual	21.2	94
PM ₁₀	24-hour	58.4	150
	Annual	18.4	50
PM _{2.5}	24-hour	30.3	35
	Annual	11.0	15
CO	1-week ⁽²⁾	521.5	1,800,000

⁽¹⁾ Modeled 1-hour averaging concentration from the SIL analysis, including background, was used to conservatively represent the 4-hour, 8-hour, and monthly impacts.

⁽²⁾ Modeled 8-hour average concentration from the SIL analysis, including background, was used to conservatively represent the 1-week average.

The impact of the emissions on soils in the vicinity of the Winchester facility was evaluated. The soil type was determined from data collected from the United States Department of Agriculture's Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSGUGO) database and the NRCS Web Soil Survey tool. The soil types within the nearby counties of Clarke in Virginia and Jefferson and Berkeley in West Virginia were also determined.

The predominant soil type in Frederick County, in which the Winchester facility is located, is silt loam but some small areas of sandy loam and rocky loam are also present. The predominant soil type in Clarke County is also silt loam, with some areas of silty clay and rocky outcrops. Jefferson County is dominated by silt loam and Berkeley County includes primarily silt loam and rocky outcrops.

The soil types in these counties are generally considered to have a moderate to high buffering capacity and have a higher capacity to absorb acidic deposition without changing the soil pH. Based on the soil types and quantity of emissions from the proposed project, no adverse impact on local soils is anticipated.

A discussion of the impacts of acidic deposition in Shenandoah National Park is provided in Section C of this memorandum (Class I Area Modeling Analysis).

Growth

The work force for the proposed modified facility is expected to be approximately 70 workers during the construction phase of the project. It is expected that most if not all of these workers will already reside and conduct business in the region surrounding the Winchester facility. Therefore, it is anticipated that no new housing, commercial, or industrial construction is necessary to support the Winchester facility during the construction schedule. The proposed project is not expected to increase full-time employment after the construction phase of the project is completed so it is anticipated that no new housing requirements or commercial construction activity would be necessary. Additionally, no significant level of industrial related support will be necessary for the Winchester facility. Therefore, industrial growth is not expected.

Based on the growth expectations discussed above, no new significant emissions from secondary growth during the construction and operation phases of the modified Winchester facility are anticipated.

C. Class I Area Modeling Analysis

The FLMs are provided reviewing authority of Class I areas that may be affected by emissions from a proposed source by the PSD regulations and are specifically charged with protecting the Air Quality Related Values (AQRV) within the Class I areas. The closest Class I area to the Winchester facility is the Shenandoah National Park (SNP). It is approximately 41 km from the project site. The next closest Class I area, Dolly Sods Wilderness Area in West Virginia, is approximately 113 km from the Winchester facility. The other Class I areas within 300 km of the Winchester facility but located at a distance greater than 113 km are the Otter Creek Wilderness Area and James River Face Wilderness Area.

Modeling guidance contained in the *Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report – Revised (2010)* provides screening criteria for determining whether a source may be excluded from performing a Class I area AQRV modeling analysis. The FLMs may consider excluding a source from modeling if its total SO₂, NO_x, PM₁₀, and H₂SO₄ annual emissions (in tons per year, based on 24-hour maximum allowable emissions) divided by the distance (in km) from the Class I area is less than or equal to 10. The sum of the emissions for the proposed project is not expected to exceed approximately 875 tons per year (tpy). Therefore, the FLAG 2010 screening criteria for the SNP is 21.3 (875 tpy/41 km). The screening distance for all other Class I areas is less than 7.8 (875 tpy/113 km or greater). Based on the FLM screening criteria, an AQRV analysis was conducted for the SNP. The USFS did not require an analysis of the more

distant Class I areas (Dolly Sods Wilderness Area, Otter Creek Wilderness Area, and James River Face Wilderness Area).

A preliminary modeling analysis for SO₂, NO₂, and PM₁₀ was conducted to determine whether or not the predicted maximum ambient air impacts in the SNP were above the Class I SILs. The emissions used in the Class I area modeling were the same as those used for the Class II area modeling. A more refined air quality modeling analysis (i.e., cumulative impact analysis) would be required to assess compliance with the Class I PSD increments for impacts predicted to be equal to or above the Class I SIL. No additional air quality analysis would be required for pollutants when the proposed project's impacts were less than the SIL.

The proposed project's maximum predicted ambient air concentrations for SO₂, NO₂, and PM₁₀ in the SNP are presented in Table 5. The maximum predicted concentrations for SO₂ (3-hour and 24-hour averaging periods), NO₂ (annual averaging period), and PM₁₀ (24-hour averaging period) were above the applicable Class I SILs in the SNP. Therefore, a cumulative impact analysis was required for these pollutants and averaging periods. Additionally, a full impact analysis to assess compliance with the Class I PSD increments for PM_{2.5} (24-hour and annual averaging periods) was conducted because there are no applicable SILs for this pollutant.

Table 5
 Summary of Maximum Predicted Concentrations from the Carmeuse
 Lime & Stone Winchester Facility for Shenandoah National Park

Pollutant	Averaging Period	Maximum Predicted Concentration From Proposed Modified Facility (µg/m ³)	Class I Significant Impact Level (µg/m ³)
SO ₂	3-hour	14.00	1.0
	24-hour	2.39	0.2
	Annual	0.09	0.1
NO ₂	Annual	0.15	0.1
PM ₁₀	24-hour	0.61	0.3
	Annual	0.03	0.2

PSD Increment Analysis

The PSD increment analysis included emissions from the proposed modified facility and emissions from increment-consuming sources from Virginia, West Virginia, and Maryland. Table 6 presents the results of the PSD increment analysis. All predicted impacts are less than the applicable PSD increments.

Table 6
 PSD Increment Modeling - Cumulative Impact Results for Shenandoah National Park

Pollutant	Averaging Period	Modeled Concentration From All Sources ($\mu\text{g}/\text{m}^3$)	Class I PSD Increment ($\mu\text{g}/\text{m}^3$)
SO ₂	3-hour	15.81	25
	24-hour	3.68	5
NO ₂	Annual	0.70	2.5
PM ₁₀	24-hour	2.00	8
PM _{2.5}	24-hour	1.98	2
	Annual	0.15	1

Air Quality Related Values

An AQRV analysis (acidic deposition and visibility) was performed for the Class I area (i.e., SNP) and is discussed in the sections below.

Acidic Deposition

An analysis of the potential sulfur (S) and nitrogen (N) deposition at the SNP was conducted in accordance with guidance from the FLM. The results of the analysis were compared to the sulfur and nitrogen deposition analysis threshold (DAT) of 0.010 kilograms per hectare per year (kg/ha/yr) for eastern Class I areas. The DAT is defined as the additional amount of sulfur or nitrogen deposition within a Class I area, below which estimated impacts from a proposed new or modified source are considered insignificant. The DAT is a deposition threshold, not necessarily an adverse impact threshold. If the additional amount of deposition is greater than or equal to the DAT, further analysis is usually required by DEQ and the FLM.

Table 7 presents a summary of the maximum predicted sulfur and nitrogen deposition rates for the SNP. The maximum predicted sulfur and nitrogen deposition rates were below their respective DAT.

Table 7
Maximum Predicted Annual Sulfur and Nitrogen Deposition Rates from the
Carmeuse Lime & Stone Winchester Facility for Shenandoah National Park

Maximum Predicted Sulfur Deposition (kg S/ha/yr)	Deposition Analysis Threshold for S (kg S/ha/yr)	Maximum Predicted Nitrogen Deposition (kg N/ha/yr)	Deposition Analysis Threshold for N (kg N/ha/yr)
0.009	0.010	0.008	0.010

Visibility

A visibility screening modeling analysis using the VISCREEN model was conducted to assess the potential for visual plume impacts inside the SNP within 50 km of the project site. The modeling approach followed guidance provided in EPA's *Workbook for Plume Visual Impact Screening and Analysis (Revised) (October 1992; EPA-454/R-92-023)*. The two visibility metrics that were evaluated in the VISCREEN modeling analysis are:

- **Plume contrast (|C|):** Contrast can be defined at any wavelength as the relative difference in the intensity (called spectral radiance) between the viewed object (e.g., plume) and its background (e.g., sky). Plume contrast results from an increase or decrease in light transmitted from the viewing background through the plume to the observer.
- **Plume perceptibility (ΔE):** A parameter used to characterize the perceptibility of a plume on the basis of the color difference between the plume and a viewing background such as the sky, a cloud, or a terrain feature.

All VISCREEN results were below the significance criteria in the SNP. Therefore, the plume is expected to be imperceptible against the background sky and the terrain.

Additionally, a visibility analysis to assess the impacts inside the SNP beyond 50 km of the Winchester facility was conducted using the CALPUFF modeling system. The visibility analysis determined the change in light extinction from background conditions for each day of the three-year meteorological period (2001-2003) due to the proposed modified facility and then compared the 8th highest (98th percentile) predicted light extinction change value to the threshold value of 5% change in light extinction. The results indicated all 98th percentile values for change in light extinction were less than 5% for any year.

Summary of Class I Area Analysis

Based on DEQ's review of the modeling analyses, the proposed modified Carmeuse Lime & Stone Winchester facility does not cause or significantly contribute to a predicted violation of any applicable NAAQS or Class I area PSD increment.

The PSD regulations provide reviewing authority to the FLM. In accordance with 9 VAC 5-80-1765 D, the FLM has an opportunity to notify DEQ of any adverse impact on the AQRVs. The FLM's authority to make a determination of an adverse impact on the AQRVs is invoked most frequently in the context of the preconstruction permit review procedure specified in Section 165 of the Clean Air Act. In the event that any adverse impact comments are received, DEQ will address the new information and revise this analysis, if warranted.

ATTACHMENT C:

Applicant's Emissions Calculations

Emission Increase Summary

Table B.1-1. Winchester Plant Annual Throughput Information

Material or Parameter	2007 Throughputs	2008 Throughputs	Annual Average	Potential Throughput	Units
Hours of Operation					
Existing Kiln Throughput					
Kiln 1 (Lime)	107,168	96,621	101,895		tons/yr
Kiln 1 (Coal)	33,335	31,830	32,583		tons/yr
Crushing/Material Handling					
Limestone Material Handling				600,000	tons/yr
Limestone Material Handling				3,840	tons/day
Lime Loadout				471,000	tons/yr
Number of Raw Material Trucks				5,652	Vehicles/yr
Number of Product Trucks				13,652	Vehicles/yr
Number of Fuel Trucks				1,784	Vehicles/yr
New Vertical Kiln					
Exhaust Flow				44,500	ACFM
Exhaust Flow				30,759	SCFM
Nominal Lime Throughput				440	tons/day/kiln
Maximum Lime Throughput				528	ton/day/kiln
Coal/Coke Heat Requirement				3.24	MMBtu/ton lime
Natural Gas Heat Requirement				3.18	MMBtu/ton lime
Coke Heating Value				24.80	MMBtu/ton coke
Coal Heating Value				24.93	MMBtu/ton coal
Natural Gas Heating Value				1.028	MMBtu/MSCF
Maximum Coke Sulfur Content				7	wt%
Maximum Coal Sulfur Content				3	wt%
Maximum Lime Throughput				157,000	tons/yr/kiln
Maximum Lime Throughput				314,000	tons/yr
Maximum Coke Throughput				69.0	ton/day/kiln
Maximum Coke Throughput				20,511	tons/yr/kiln
Maximum Coke Throughput				41,023	tons/yr
Maximum Coal Throughput				68.6	ton/day/kiln
Maximum Coal Throughput				20,404	tons/yr/kiln
Maximum Coal Throughput				40,809	tons/yr
Maximum Natural Gas Throughput				1,633	MSCF/day/kiln
Maximum Natural Gas Throughput				485,661	MSCF/yr/kiln
Maximum Natural Gas Throughput				971,323	MSCF/yr

Table B.1-2. Criteria Emission Factor Calculations - Coal/Coke

Pollutant	Vertical Kiln Emission Factor	Units	Source	Emission Factor (lb/ton)
Condensable PM	--	--	1	1.82E-01
Filterable PM	1.00E-02	grains/ft ³	2	1.44E-01
Filterable PM ₁₀	1.00E-02	grains/ft ³	2	1.44E-01
Filterable PM _{2.5}	5.00E-03	grains/ft ³	2	7.19E-02
NO _x	--	--	3	2.50E+00
SO ₂	--	--	3	1.30E+00
CO	--	--	3	3.00E+00
VOC	25	mg/Nm ³	4	1.61E-01
Lead	--	--	5	4.20E-04
Sulfuric Acid Mist (Coke)	2.20E-03	lb / lb S	6	4.02E-02
Sulfuric Acid Mist (Coal)	2.20E-03	lb / lb S	6	1.72E-02
HCl	--	--	5	1.20E+00
HF	--	--	5	1.50E-01

¹ Condensable PM emission factor is the maximum value from the Winchester facility during the 11/9/06 stack test.

² Based on bagfilter outlet grain loading rate of 0.01 grains per dry standard cubic foot (gr/dscf). Assumes all PM is PM_{2.5}.

³ Engineering estimate based on kiln design and emissions from similar kilns. See Table B.1-4 for detailed information from stack testing on similar kilns.

⁴ Based on data provided from kiln vendor. Exhaust flow measured at 284 °F or 413.15 K. Emission are calculated at normal conditions (293.15 K).

⁵ Emission factors from EPA AP-42 Section 1.1, Bituminous and Subbituminous Coal Combustion (9/98).

⁶ Emission factor from Chemical Lime's Clifton, TX Kiln 3 permit renewal application (September 2009).

Sample Calculations:

$$\text{PM Emission Factor (lb/ton)} = \frac{1.00\text{E-}02 \text{ gr}}{\text{ft}^3} \times \frac{30,759 \text{ scf}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{\text{lb}}{7,000 \text{ gr}} \times \frac{\text{day}}{440 \text{ ton}} = \frac{0.144 \text{ lb}}{\text{ton}}$$

$$\text{VOC Emission Factor (lb/ton)} = \frac{25 \text{ mg}}{\text{Nm}^3} \times \frac{\text{g}}{1,000 \text{ mg}} \times \frac{\text{lb}}{453.492 \text{ g}} \times \frac{44,500 \text{ acf}}{\text{min}} \times \frac{293.15 \text{ K}}{413.15 \text{ K}} \times \frac{\text{m}^3}{35.32 \text{ ft}^3} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{24 \text{ hr}}{\text{day}} \times \frac{\text{day}}{440 \text{ ton}} = \frac{0.16 \text{ lb}}{\text{ton}}$$

Note:

To calculate a volume of gas at "normal" (N) conditions, the value at "actual" (A) conditions is multiplied by 293.15 K and divided by the actual temperature.

Table B.1-3. Criteria Emission Factor Calculations - Natural Gas

Pollutant	Vertical Kiln Emission Factor	Units	Source	Emission Factor (lb/ton)
Condensable PM	--	--	1	1.82E-01
Filterable PM	1.00E-02	grains/ft ³	2	1.44E-01
Filterable PM ₁₀	1.00E-02	grains/ft ³	2	1.44E-01
Filterable PM _{2.5}	1.00E-02	grains/ft ³	2	7.19E-02
NO _x	--	--	3	1.04E+00
SO ₂	--	--	3	6.00E-02
CO	--	--	3	1.31E+00
VOC	25	mg/Nm ³	4	1.61E-01

¹ Condensable PM emission factor is the maximum value from the Winchester facility during the 11/9/06 stack test.

² Based on bagfilter outlet grain loading rate of 0.01 grains per dry standard cubic foot (gr/dscf). Assumes all PM is PM_{2.5}.

³ Engineering estimate based on kiln design and emissions from similar kilns.

⁴ Based on vendor guarantee. Exhaust flow measured at 284 °F or 413.15 K. Emission are calculated at normal conditions (293.15 K).

Table B.1-4. Emission Test Summary

Pollutant	Avg Emission Factor (lb/ton lime)	Standard Deviation (lb/ton lime)	Maximum Emission Factor (lb/ton lime)	Number of Kilns Tested
NO _x	1.04E+00	8.32E-01	2.19E+00	21
SO ₂ ¹	3.74E-01	3.63E-01	1.16E+00	19
CO	1.31E+00	4.13E-01	2.32E+00	16

¹ Test data is SO_x, assumes SO_x=SO₂.

Table B.2-1. Annual Emission Increase Summary (tpy)

Source	PM	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	VOC	SAM	GHG
Potential Emissions from Project									
New Vertical Kiln 1	25.87	25.87	20.15	198.44	102.18	238.26	13.00	3.16	180,991
New Vertical Kiln 2	25.87	25.87	20.15	198.44	102.18	238.26	13.00	3.16	180,991
Limestone Handling	13.84	9.07	3.06						
Fuel Preparation	6.23	6.21	2.48	0.75	0.01	1.25	0.08		1,794
Lime Handling	28.11	28.11	11.24						
Roads	8.57	2.24	0.29						
Emergency Engine	0.02	0.02	0.02	0.33	0.10	0.29	0.33		57
Potential Emissions Increase From Project	108.51	97.38	57.40	397.96	204.46	478.07	26.41	6.32	363,833
Emission Reductions from Existing Kiln 1 Shutdown					-170.7				
Emissions Increase from Project	108.5	97.4	57.4	398.0	204.5	478.1	26.4	6.3	363,833
Contemporaneous Emission Reductions					-170.7				
Net Emission Increase	108.5	97.4	57.4	398.0	33.8	478.1	26.4	6.3	363,833
SER	25	15	10	40	40	100	40	7	75,000
Exceeds	YES	YES	YES	YES	No	YES	No	No	YES

Table B.2-2. Hourly Potential Emission Summary (lb/hr)

Source	PM	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	VOC	SAM	GHG
Potential Emissions from Project									
New Vertical Kiln 1	7.16	7.16	5.58	55.00	28.60	66.00	3.55	0.89	50,724
New Vertical Kiln 2	7.16	7.16	5.58	55.00	28.60	66.00	3.55	0.89	50,724
Limestone Handling	12.08	5.89	1.48						
Fuel Preparation	1.67	1.53	0.58	0.17	0.00	0.29	0.02		409.51
Lime Handling	6.42	6.42	2.57						
Roads	2.93	0.77	0.10						
Emergency Engine	0.07	0.07	0.07	1.32	0.41	1.16	1.32		229.04
Potential Emissions From Project	37.48	28.99	15.95	111.49	57.61	133.44	8.44	1.77	102,086

Table B.2-3. Emission Increase Threshold Comparison

Pollutant	Potential Project Emissions (A) (tpy)	PSD Significant Emission Rate (tpy)	Netting Option Triggered Yes/No	Emission Decreases (B) (tpy)	Net Emission Increase (A+B) (tpy)	Trigger PSD Yes/No
PM	108.5	25	Yes		108.5	Yes
PM ₁₀	97.4	15	Yes		97.4	Yes
PM _{2.5}	57.4	10	Yes		57.4	Yes
NO _x	398.0	40	Yes		398.0	Yes
SO ₂	204.5	40	Yes		204.5	Yes
CO	478.1	100	Yes		478.1	Yes
VOC	26.4	40	No		26.4	No
SAM	6.3	7	No		6.3	No
GHG	363,833	75,000	Yes		363,833	Yes

Table B.2-4. HAP Emission Summary

Pollutant	Potential Emissions								Coal/Coke Mill (lb/hr) (tpy)	Emergency Engine (lb/hr) (tpy)	Project Summary (lb/hr) (tpy)			
	Vertical Kilns Coal/Coke Combustion				Vertical Kilns Natural Gas Combustion									
	VK #1 (lb/hr)	VK #1 (tpy)	VK #2 (lb/hr)	VK #2 (tpy)	VK #1 (lb/hr)	VK #1 (tpy)	VK #2 (lb/hr)	VK #2 (tpy)						
Acetaldehyde	1.64E-03	5.85E-03	1.64E-03	5.85E-03						1.07E-03	2.68E-04	4.35E-03	1.20E-02	
Acetophenone	4.31E-05	1.54E-04	4.31E-05	1.54E-04								8.62E-05	3.08E-04	
Acrolein	8.34E-04	2.97E-03	8.34E-04	2.97E-03						1.30E-04	3.24E-05	1.80E-03	5.98E-03	
Antimony	5.17E-05	1.85E-04	5.17E-05	1.85E-04								1.03E-04	3.69E-04	
Arsenic	1.18E-03	4.20E-03	1.18E-03	4.20E-03	1.36E-05	4.86E-05	1.36E-05	4.86E-05	6.81E-07	2.98E-06	1.31E-03	3.27E-04	3.66E-03	8.74E-03
Benzene	3.74E-03	1.33E-02	3.74E-03	1.33E-02	1.43E-04	5.10E-04	1.43E-04	5.10E-04	7.15E-06	3.13E-05			7.48E-03	2.67E-02
Benz(a)pyrene	1.09E-07	3.90E-07	1.09E-07	3.90E-07							2.63E-07	6.58E-08	4.82E-07	8.45E-07
Benzyl chloride	2.01E-03	7.18E-03	2.01E-03	7.18E-03									4.02E-03	1.44E-02
Beryllium	6.04E-05	2.15E-04	6.04E-05	2.15E-04	8.17E-07	2.91E-06	8.17E-07	2.91E-06	4.09E-08	1.79E-07			1.21E-04	4.31E-04
Biphenyl	4.89E-06	1.74E-05	4.89E-06	1.74E-05									9.77E-06	3.49E-05
Bis(2-ethylhexyl)phthalate (DEHP)	2.10E-04	7.49E-04	2.10E-04	7.49E-04									4.20E-04	1.50E-03
Bromoform	1.12E-04	4.00E-04	1.12E-04	4.00E-04									2.24E-04	8.00E-04
1,3 Butadiene											5.47E-05	1.37E-05	5.47E-05	1.37E-05
Cadmium	1.47E-04	5.23E-04	1.47E-04	5.23E-04	7.49E-05	2.67E-04	7.49E-05	2.67E-04	3.75E-06	1.64E-05			2.97E-04	1.06E-03
Carbon disulfide	3.74E-04	1.33E-03	3.74E-04	1.33E-03									7.47E-04	2.67E-03
2-Chloroacetophenone	2.01E-05	7.18E-05	2.01E-05	7.18E-05									4.02E-05	1.44E-04
Chlorobenzene	6.32E-05	2.26E-04	6.32E-05	2.26E-04									1.26E-04	4.51E-04
Chloroform	1.70E-04	6.05E-04	1.70E-04	6.05E-04									3.39E-04	1.21E-03
Chromium (VI)	2.27E-04	8.10E-04	2.27E-04	8.10E-04	9.53E-05	3.40E-04	9.53E-05	3.40E-04	4.77E-06	2.09E-05			4.59E-04	1.64E-03
Cobalt	2.87E-04	1.03E-03	2.87E-04	1.03E-03	5.72E-06	2.04E-05	5.72E-06	2.04E-05	2.86E-07	1.25E-06			5.75E-04	2.05E-03
Cumene	1.52E-05	5.44E-05	1.52E-05	5.44E-05									3.05E-05	1.09E-04
Cyanide	7.19E-03	2.56E-02	7.19E-03	2.56E-02									1.44E-02	5.13E-02
Dibenzofurans (Total PCDF)	5.06E-09	1.80E-08	5.06E-09	1.80E-08									1.01E-08	3.61E-08
Dichlorobenzene					8.17E-05	2.91E-04	8.17E-05	2.91E-04	4.09E-06	1.79E-05			1.67E-04	6.01E-04
Dimethyl sulfate	1.38E-04	4.92E-04	1.38E-04	4.92E-04									2.76E-04	9.85E-04
2,4-Dinitrotoluene	8.05E-07	2.87E-06	8.05E-07	2.87E-06									1.61E-06	5.74E-06
Ethyl benzene	2.70E-04	9.64E-04	2.70E-04	9.64E-04									5.40E-04	1.93E-03
Ethyl chloride	1.21E-04	4.31E-04	1.21E-04	4.31E-04									2.41E-04	8.61E-04
Ethylene dibromide	3.45E-06	1.23E-05	3.45E-06	1.23E-05									6.90E-06	2.46E-05
Ethylene dichloride	1.15E-04	4.10E-04	1.15E-04	4.10E-04									2.30E-04	8.20E-04
Formaldehyde	6.90E-04	2.46E-03	6.90E-04	2.46E-03	5.10E-03	1.82E-02	5.10E-03	1.82E-02	2.55E-04	1.12E-03	1.65E-03	4.13E-04	1.21E-02	3.80E-02
Hexane	1.93E-04	6.87E-04	1.93E-04	6.87E-04	1.22E-01	4.37E-01	1.22E-01	4.37E-01	6.13E-03	2.68E-02			2.51E-01	9.01E-01
Isophorone	1.67E-03	5.95E-03	1.67E-03	5.95E-03									3.33E-03	1.19E-02
Lead	1.21E-03	4.31E-03	1.21E-03	4.31E-03	3.40E-05	1.21E-04	3.40E-05	1.21E-04	1.70E-06	7.46E-06			2.42E-03	8.62E-03
Manganese	1.41E-03	5.03E-03	1.41E-03	5.03E-03	2.59E-05	9.23E-05	2.59E-05	9.23E-05	1.29E-06	5.67E-06			2.82E-03	1.01E-02
Mercury	2.39E-04	8.51E-04	2.39E-04	8.51E-04	1.77E-05	6.31E-05	1.77E-05	6.31E-05	8.85E-07	3.88E-06			4.78E-04	1.71E-03
Methyl bromide	4.60E-04	1.64E-03	4.60E-04	1.64E-03									9.20E-04	3.28E-03
Methyl chloride	1.52E-03	5.44E-03	1.52E-03	5.44E-03									3.05E-03	1.09E-02
Methyl hydrazine	4.89E-04	1.74E-03	4.89E-04	1.74E-03									9.77E-04	3.49E-03
Methyl methacrylate	5.75E-05	2.05E-04	5.75E-05	2.05E-04									1.15E-04	4.10E-04
Methyl tert-butyl ether	1.01E-04	3.59E-04	1.01E-04	3.59E-04									2.01E-04	7.18E-04
Methylene chloride	8.34E-04	2.97E-03	8.34E-04	2.97E-03									1.67E-03	5.95E-03
Naphthalene	3.74E-05	1.33E-04	3.74E-05	1.33E-04	4.15E-05	1.48E-04	4.15E-05	1.48E-04	2.08E-06	9.10E-06			8.51E-05	3.05E-04
Nickel	8.05E-04	2.87E-03	8.05E-04	2.87E-03	1.43E-04	5.10E-04	1.43E-04	5.10E-04	7.15E-06	3.13E-05			1.62E-03	5.77E-03
Phenol	4.60E-05	1.64E-04	4.60E-05	1.64E-04									9.20E-05	3.28E-04
Total Polyorganic Matter (POM)	1.55E-04	5.55E-04	1.55E-04	5.55E-04	6.00E-06	2.14E-05	6.00E-06	2.14E-05	3.00E-07	1.32E-06	2.35E-04	5.88E-05	5.46E-04	1.17E-03
Propionaldehyde	1.09E-03	3.90E-03	1.09E-03	3.90E-03									2.18E-03	7.79E-03
Selenium	3.74E-03	1.33E-02	3.74E-03	1.33E-02	1.63E-06	5.83E-06	1.63E-06	5.83E-06	8.17E-08	3.58E-07			7.47E-03	2.67E-02
Styrene	7.19E-05	2.56E-04	7.19E-05	2.56E-04									1.44E-04	5.13E-04
Tetrachloroethylene	1.24E-04	4.41E-04	1.24E-04	4.41E-04									2.47E-04	8.82E-04
Toluene	6.90E-04	2.46E-03	6.90E-04	2.46E-03	2.31E-04	8.26E-04	2.31E-04	8.26E-04	1.16E-05	5.07E-05	5.73E-04	1.43E-04	1.96E-03	5.12E-03
1,1,1-Trichloroethane	5.75E-05	2.05E-04	5.75E-05	2.05E-04									1.15E-04	4.10E-04
Vinyl acetate	2.18E-05	7.79E-05	2.18E-05	7.79E-05									4.37E-05	1.56E-04
Xylenes	1.06E-04	3.79E-04	1.06E-04	3.79E-04							3.99E-04	9.98E-05	6.12E-04	8.59E-04

Table B.3-1. Existing Kiln 1 Production Data

	Historical Production ¹	Units
Lime Production	101,895	ton/yr
Coal Usage	32,583	ton/yr

Table B.3-2. Existing Kiln 1 Emission Calculations

Pollutant	Existing Kiln Emission Factor	Units	Source	Baseline Emissions (tpy)
Total (filt + cond) PM	2.74E-01	lb/ton product	2	13.98
Total (filt + cond) PM ₁₀	1.69E-01	lb/ton product	2	8.62
Total (filt + cond) PM _{2.5}	1.69E-01	lb/ton product	2	8.62
NO _x	3.14E+00	lb/ton product	3	159.97
SO ₂	3.35E+00	lb/ton product	3	170.67
CO	2.80E-01	lb/ton product	3	14.27
VOC	2.00E-02	lb/ton product	4	1.02
HCl	1.20E+00	lb/ton coal	5	19.55
HF	1.50E-01	lb/ton coal	5	2.44

¹ Baseline production values are the annual average from January 2007 through December 2008.

² Emission factors taken from December 2006 performance test.

³ Emission factors taken from April 2007 performance test.

⁴ VOC emission factor from EPA WebFIRE database for Vertical Lime Kilns SCC 30501603.

⁵ Emission factors from EPA AP-42 Section 1.1, *Bituminous and Subbituminous Coal Combustion* (9/98). Emissions calculated based on baseline coal throughput

Table B.4-1. Production Data

	Potential Production	Units
Lime Production per Kiln	528	ton/day
Lime Production per Kiln	157,000	ton/yr
Coke Usage per Kiln	69.0	ton/day
Coke Usage per Kiln	20,511	ton/yr
Maximum Coke Sulfur Content	7	wt%
Coal Usage per Kiln	68.6	ton/day
Coal Usage per Kiln	20,404	ton/yr
Maximum Coal Sulfur Content	3	wt%

Table B.4-2. Vertical Kiln Emissions - Coal/Coke Firing

Pollutant	Emission Factors (lb/ton)	VK #1 (lb/hr)	Potential Emissions		
			VK #1 (tpy)	VK #2 (lb/hr)	VK #2 (tpy)
Total (filt + cond) PM	3.25E-01	7.16	25.55	7.16	25.55
Total (filt + cond) PM ₁₀	3.25E-01	7.16	25.55	7.16	25.55
Total (filt + cond) PM _{2.5}	2.54E-01	5.58	19.90	5.58	19.90
NO _x	2.50E+00	55.00	196.25	55.00	196.25
SO ₂	1.30E+00	28.60	102.05	28.60	102.05
CO	3.00E+00	66.00	235.50	66.00	235.50
VOC	1.61E-01	3.55	12.66	3.55	12.66
Lead	4.20E-04	1.20E-03	4.28E-03	1.20E-03	4.28E-03
Sulfuric Acid Mist (coke)	4.02E-02	0.89	3.16	0.89	3.16
Sulfuric Acid Mist (coal)	1.72E-02	0.38	1.35	0.38	1.35
HCl	1.20E+00	3.43	12.24	3.43	12.24
HF	1.50E-01	0.43	1.53	0.43	1.53

Table B.4-3. Vertical Kiln Emissions - Natural Gas Firing

Pollutant	Emission Factors (lb/ton)	VK #1 (lb/hr)	Potential Emissions		
			VK #1 (tpy)	VK #2 (lb/hr)	VK #2 (tpy)
Total (filt + cond) PM	3.25E-01	7.16	25.55	7.16	25.55
Total (filt + cond) PM ₁₀	3.25E-01	7.16	25.55	7.16	25.55
Total (filt + cond) PM _{2.5}	2.54E-01	5.58	19.90	5.58	19.90
NO _x	1.04E+00	22.83	81.44	22.83	81.44
SO ₂	6.00E-02	1.32	4.71	1.32	4.71
CO	1.31E+00	28.77	102.66	28.77	102.66
VOC	1.61E-01	3.55	12.66	3.55	12.66

Table B.4-4. Vertical Kiln Emissions - Uncontrolled SO₂ Emissions

Operating Mode	VK #1 (lb/hr)	Potential Emissions		VK #2 (tpy)
		VK #1 (tpy)	VK #2 (lb/hr)	
Coke	402.39	1,435.79	402.39	1,435.79
Coal	171.55	612.13	171.55	612.13

Table B.4-5. Vertical Kiln Emissions - Startup/Shutdown

Pollutant	VK #1 (lb/hr)	Potential Emissions		VK #2 (tpy) ¹
		VK #1 (tpy) ¹	VK #2 (lb/hr)	
Total (filt + cond) PM ²	7.16	0.33	7.16	0.33
Total (filt + cond) PM ₁₀ ²	7.16	0.33	7.16	0.33
Total (filt + cond) PM _{2.5} ²	5.58	0.25	5.58	0.25
NO _x ³	22.83	2.19	22.83	2.19
SO ₂ ³	1.32	0.13	1.32	0.13
CO ³	28.77	2.76	28.77	2.76
VOC ³	3.55	0.34	3.55	0.34

¹ Based on nominal production rate, the kiln will operate 357 days per year. Annual emissions assume startup/shutdown emissions are the remaining 8 days in the year.

² Annual SU/SD emissions calculated using average hourly emission rate during the startup period. The lb/hr value is the maximum emission rate during startup.

³ SU/SD emissions assume hourly emission rate for natural gas production for every hour of startup (i.e., SU Emissions = NG Emissions (lb/hr) × 24 hr/day × 8 day/startup. This estimate is overly conservative as emissions gradually increase during startup until production begins on natural gas.

Table B.4-6. Production Data

	Potential Production	Units
Coke Usage per Kiln	69.0	ton/day
Coke Usage per Kiln	20,511	ton/yr
Natural Gas Usage per Kiln	1,633	Mscf/day
Natural Gas Usage per Kiln	485,661	Mscf/year

Table B.4-7. Vertical Kiln HAP Emissions - Coal/Coke Firing

Pollutant	Emission Factors (lb/ton)	VK #1 (lb/hr)	Potential Emissions VK #1 (tpy)	VK #2 (lb/hr)	VK #2 (tpy)
Acetaldehyde	5.70E-04	1.64E-03	5.85E-03	1.64E-03	5.85E-03
Acetophenone	1.50E-05	4.31E-05	1.54E-04	4.31E-05	1.54E-04
Acrolein	2.90E-04	8.34E-04	2.97E-03	8.34E-04	2.97E-03
Antimony	1.80E-05	5.17E-05	1.85E-04	5.17E-05	1.85E-04
Arsenic	4.10E-04	1.18E-03	4.20E-03	1.18E-03	4.20E-03
Benzene	1.30E-03	3.74E-03	1.33E-02	3.74E-03	1.33E-02
Benzo(a)pyrene	3.80E-08	1.09E-07	3.90E-07	1.09E-07	3.90E-07
Benzyl chloride	7.00E-04	2.01E-03	7.18E-03	2.01E-03	7.18E-03
Beryllium	2.10E-05	6.04E-05	2.15E-04	6.04E-05	2.15E-04
Biphenyl	1.70E-06	4.89E-06	1.74E-05	4.89E-06	1.74E-05
Bis(2-ethylhexyl)phthalate (7.30E-05	2.10E-04	7.49E-04	2.10E-04	7.49E-04
Bromoform	3.90E-05	1.12E-04	4.00E-04	1.12E-04	4.00E-04
Cadmium	5.10E-05	1.47E-04	5.23E-04	1.47E-04	5.23E-04
Carbon disulfide	1.30E-04	3.74E-04	1.33E-03	3.74E-04	1.33E-03
2-Chloroacetophenone	7.00E-06	2.01E-05	7.18E-05	2.01E-05	7.18E-05
Chlorobenzene	2.20E-05	6.32E-05	2.26E-04	6.32E-05	2.26E-04
Chloroform	5.90E-05	1.70E-04	6.05E-04	1.70E-04	6.05E-04
Chromium (VI)	7.90E-05	2.27E-04	8.10E-04	2.27E-04	8.10E-04
Cobalt	1.00E-04	2.87E-04	1.03E-03	2.87E-04	1.03E-03
Cumene	5.30E-06	1.52E-05	5.44E-05	1.52E-05	5.44E-05
Cyanide	2.50E-03	7.19E-03	2.56E-02	7.19E-03	2.56E-02
Dibenzofurans (Total PCDF	1.76E-09	5.06E-09	1.80E-08	5.06E-09	1.80E-08
Dimethyl sulfate	4.80E-05	1.38E-04	4.92E-04	1.38E-04	4.92E-04
2,4-Dinitrotoluene	2.80E-07	8.05E-07	2.87E-06	8.05E-07	2.87E-06
Ethyl benzene	9.40E-05	2.70E-04	9.64E-04	2.70E-04	9.64E-04
Ethyl chloride	4.20E-05	1.21E-04	4.31E-04	1.21E-04	4.31E-04
Ethylene dibromide	1.20E-06	3.45E-06	1.23E-05	3.45E-06	1.23E-05
Ethylene dichloride	4.00E-05	1.15E-04	4.10E-04	1.15E-04	4.10E-04
Formaldehyde	2.40E-04	6.90E-04	2.46E-03	6.90E-04	2.46E-03
Hexane	6.70E-05	1.93E-04	6.87E-04	1.93E-04	6.87E-04
Isophorone	5.80E-04	1.67E-03	5.95E-03	1.67E-03	5.95E-03
Lead	4.20E-04	1.21E-03	4.31E-03	1.21E-03	4.31E-03
Manganese	4.90E-04	1.41E-03	5.03E-03	1.41E-03	5.03E-03
Mercury	8.30E-05	2.39E-04	8.51E-04	2.39E-04	8.51E-04
Methyl bromide	1.60E-04	4.60E-04	1.64E-03	4.60E-04	1.64E-03
Methyl chloride	5.30E-04	1.52E-03	5.44E-03	1.52E-03	5.44E-03
Methyl hydrazine	1.70E-04	4.89E-04	1.74E-03	4.89E-04	1.74E-03
Methyl methacrylate	2.00E-05	5.75E-05	2.05E-04	5.75E-05	2.05E-04
Methyl tert-butyl ether	3.50E-05	1.01E-04	3.59E-04	1.01E-04	3.59E-04
Methylene chloride	2.90E-04	8.34E-04	2.97E-03	8.34E-04	2.97E-03
Naphthalene	1.30E-05	3.74E-05	1.33E-04	3.74E-05	1.33E-04
Nickel	2.80E-04	8.05E-04	2.87E-03	8.05E-04	2.87E-03
Phenol	1.60E-05	4.60E-05	1.64E-04	4.60E-05	1.64E-04
Total Polyorganic Matter (P	5.41E-05	1.55E-04	5.55E-04	1.55E-04	5.55E-04
Propionaldehyde	3.80E-04	1.09E-03	3.90E-03	1.09E-03	3.90E-03
Selenium	1.30E-03	3.74E-03	1.33E-02	3.74E-03	1.33E-02
Styrene	2.50E-05	7.19E-05	2.56E-04	7.19E-05	2.56E-04
Tetrachloroethylene	4.30E-05	1.24E-04	4.41E-04	1.24E-04	4.41E-04
Toluene	2.40E-04	6.90E-04	2.46E-03	6.90E-04	2.46E-03
1,1,1-Trichloroethane	2.00E-05	5.75E-05	2.05E-04	5.75E-05	2.05E-04
Vinyl acetate	7.60E-06	2.18E-05	7.79E-05	2.18E-05	7.79E-05
Xylenes	3.70E-05	1.06E-04	3.79E-04	1.06E-04	3.79E-04

Table B.4-8. Vertical Kiln HAP Emissions - Natural Gas Firing

Pollutant	Emission Factors (lb/MMscf)	VK #1 (lb/hr)	Potential Emissions		
			VK #1 (tpy)	VK #2 (lb/hr)	VK #2 (tpy)
Benzene	2.10E-03	1.43E-04	5.10E-04	1.43E-04	5.10E-04
Dichlorobenzene	1.20E-03	8.17E-05	2.91E-04	8.17E-05	2.91E-04
Formaldehyde	7.50E-02	5.10E-03	1.82E-02	5.10E-03	1.82E-02
n-Hexane	1.80E+00	1.22E-01	4.37E-01	1.22E-01	4.37E-01
Naphthalene	6.10E-04	4.15E-05	1.48E-04	4.15E-05	1.48E-04
Selenium	2.40E-05	1.63E-06	5.83E-06	1.63E-06	5.83E-06
Toluene	3.40E-03	2.31E-04	8.26E-04	2.31E-04	8.26E-04
POM	8.82E-05	6.00E-06	2.14E-05	6.00E-06	2.14E-05
Arsenic	2.00E-04	1.36E-05	4.86E-05	1.36E-05	4.86E-05
Beryllium	1.20E-05	8.17E-07	2.91E-06	8.17E-07	2.91E-06
Cadmium	1.10E-03	7.49E-05	2.67E-04	7.49E-05	2.67E-04
Chromium	1.40E-03	9.53E-05	3.40E-04	9.53E-05	3.40E-04
Cobalt	8.40E-05	5.72E-06	2.04E-05	5.72E-06	2.04E-05
Lead	5.00E-04	3.40E-05	1.21E-04	3.40E-05	1.21E-04
Manganese	3.80E-04	2.59E-05	9.23E-05	2.59E-05	9.23E-05
Mercury	2.60E-04	1.77E-05	6.31E-05	1.77E-05	6.31E-05
Nickel	2.10E-03	1.43E-04	5.10E-04	1.43E-04	5.10E-04

Table B.5-1. Past Actual Throughputs

	Historical Production	Units
Lime	101,895	ton/yr
Coal	32,583	ton/yr
Coal Heating Value ¹	24.9	MMBtu/ton

Table B.5-2. Past Actual GHG Emissions

Pollutant	Global Warming Potential ²	Coal Emission Factor ¹ kg/MMBtu	Lime Production Emissions ³ (tpy)	Coal Emissions (tpy)	Total (tpy)
CO ₂	1	93.4	80,060	83,643	163,703
CH ₄	21	1.10E-02	--	9.85	9.85
NO ₂	310	1.60E-03	--	1.43	1.43
CO ₂ e	--	--	80,060	84,295	164,355

Table B.5-3. Potential Throughputs per Kiln

	Potential Production	Units
Lime	157,000	ton/yr
Lime	22	ton/hr
Coke	20,511	ton/yr
Coke	3	ton/hr
Coal	20,404	ton/yr
Coal	3	ton/hr
Natural Gas	485,661	MSCF/yr
Natural Gas	68	MSCF/hr
Coke Heating Value ¹	24.80	MMBtu/ton
Coal Heating Value ¹	24.93	MMBtu/ton
Natural Gas Heating Value ¹	1.028	MMBtu/MSCF

Table B.5-4. GHG Emission Factors

Pollutant	Global Warming Potential ²	Coke Emission Factor ¹ kg/MMBtu	Coal Emission Factor kg/MMBtu	Lignite Emission Factor kg/MMBtu	Natural Gas Emission Factor kg/MMBtu
CO ₂	1	102.04	93.4	96.36	53.02
CH ₄	21	1.10E-02	1.10E-02	1.10E-02	1.00E-03
NO ₂	310	1.60E-03	1.60E-03	1.60E-03	1.00E-04

Table B.5-5. Potential Annual GHG Emissions per Kiln

Pollutant	Lime Production Emissions ³ (tpy)	Coke Emissions (tpy)	Coal Emissions (tpy)	Lignite Emissions (tpy)	Natural Gas Emissions (tpy)	Maximum Potential Emissions ⁴ (tpy)
CO ₂	123,357	57,226	52,381	54,041	29,184	180,583
CH ₄	--	6.17	6.17	6.17	0.55	6.17
NO ₂	--	0.90	0.90	0.90	0.06	0.90
CO ₂ e	123,357	57,634	52,788	54,448	29,213	180,991

Table B.5-6. Potential Hourly GHG Emissions per Kiln

Pollutant	Lime Production Emissions ³ (lb/hr)	Coke Emissions (lb/hr)	Coal Emissions (lb/hr)	Lignite Emissions (lb/hr)	Natural Gas Emissions (lb/hr)	Maximum Potential Emissions ⁴ (lb/hr)
CO ₂	34,571.43	16,037.87	14,679.90	15,145.13	8,178.96	50,609.30
CH ₄	--	1.73	1.73	1.73	0.15	1.73
NO ₂	--	0.25	0.25	0.25	0.02	0.25
CO ₂ e	34,571.43	16,152.14	14,794.17	15,259.40	8,186.98	50,723.56

¹ Emission factors and default HHVs from 40 CFR 98, Tables C-1 and C-2 to Subpart C of Part 98.

² Global warming potentials from 40 CFR 98, Tables A-1 to Subpart A of Part 98.

³ CO₂ emissions from lime production calculated based on 1 mole of CO₂ emitted per mole of lime (CaO) produced.

⁴ Maximum potential emission based on lime production emissions and maximum fuel burning GHG emissions.

Post Project Limestone Handling Emissions

Table B.6-1. Limestone Handling Emission Factors

Source Type	Source IDs	Uncontrolled PM Emission Factor (lb/ton)	Uncontrolled PM ₁₀ Emission Factor (lb/ton)	Uncontrolled PM _{2.5} Emission Factor (lb/ton)	Wet Suppression PM Control Efficiency (%)	Wet Suppression PM ₁₀ Control Efficiency (%)
Crushing (Primary) ^{1,2}	CR-900	7.30E-04	7.10E-04	2.09E-04	95.0	95.0
Crushing (Secondary) ^{1,2}	RC-110	5.40E-03	2.40E-03	8.96E-04	77.8	77.8
Screening ^{1,2}	SN-900, SN-120, and SN-210	2.50E-02	8.70E-03	3.25E-03	91.2	91.5
Truck/Hopper Loading ^{1,2}	HOP	6.00E-02	3.00E-02	3.91E-03	95.0	95.0
Handling ³	LB-900	7.57E-04	3.58E-04	5.42E-05		
Conveyors ^{1,2}	BC-915, BC-902, BC-903, BC-904, BC-905, BC-906, BC-3, BC-9, BC-130, BC-900, BC-129, BC-901, BC-200, BC-220, BC-230, BC-320, SK-350, SK-360, PILE6, PILE7, PILE8, PILE2, PILE3, PILE4, and PILE5	3.00E-03	1.10E-03	1.43E-04	95.3	95.8
Drilling and Truck Loading ⁴	NA	1.80E-04	1.80E-04	1.80E-04	0.0	0.0

¹ Emission factors and control efficiencies taken from VDEQ's "Stone Processing Operations" (January 3, 2005). Piles are drop onto pile. Wind erosion calculated separately.

² Particle size specification data obtained from EPA PM Calculator (<http://www.epa.gov/ttn/chief/ei/information.html>):

PM_{2.5} factor is based on ratio of PM₁₀ to PM_{2.5} from EPA's PM Calculator for uncontrolled emissions.

Primary Crushing (% of total PM) [SCC 30501601]:

PM₁₀ = 51%

PM_{2.5} = 15%

Secondary Screening/Crushing (% of total PM) [SCC 30501602]:

PM₁₀ = 75%

PM_{2.5} = 28%

Raw Material Transfer and Conveying (% of total PM) [SCC 30501607]:

PM₁₀ = 23%

PM_{2.5} = 3%

Raw Material Storage Piles (% of total PM) [SCC 30501610]:

PM₁₀ = 35%

PM_{2.5} = 11%

³ AP-42 Section 13.2.4.3 - Aggregate Handling and Storage Piles, Equation (1). (11/06).

$$E = k (0.0032)(U/5)^{1.3} / (M/2)^{1.4}$$

Where:

E = emission factor

k = particle size multiplier = 0.74 for PM, 0.35 for PM₁₀, and 0.053 for PM_{2.5}

U = mean wind speed, 7.4 mph (from Dulles International Airport <http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html>)

M = material moisture content (%), 6.5% for limestone

Limestone Handling Emission Factor:

E (PM) = 7.57E-04

E (PM₁₀) = 3.58E-04

E (PM_{2.5}) = 5.42E-05

⁴ AP-42 Section 11.19.2 - Crushed Stone Processing and Pulverize Mineral Handling. (8/04). No data for PM or PM_{2.5}, so assumes all PM = PM₁₀ = PM_{2.5}.

Table B.6-2. Limestone Handling Emissions

Source ID	Description ¹	Capacity (tons/hr)	Annual Throughput Capacity (tons/yr)	PM Control Efficiency (%)	PM ₁₀ /PM _{2.5} Control Efficiency (%)	PM Emissions (lb/hr)	PM ₁₀ Emissions (lb/hr)	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy)	PM ₁₀ Emissions (tpy)	PM _{2.5} Emissions (tpy)
HOP	150 Ton Primary Dump Hopper	1,500	950,000	95.0%	95.0%	4.50E+00	2.25E+00	2.93E-01	1.43E+00	7.13E-01	9.29E-02
CR-900	Primary Jaw Crusher	1,500	950,000	95.0%	95.0%	5.48E-02	5.33E-02	1.57E-02	1.73E-02	1.69E-02	4.96E-03
BC-915	Belt Conveyor	1,500	950,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	6.70E-02	2.19E-02	2.86E-03
BC-902	Belt Conveyor	1,500	950,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	6.70E-02	2.19E-02	2.86E-03
BC-903	Belt Conveyor	1,500	950,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	6.70E-02	2.19E-02	2.86E-03
BC-904	Belt Conveyor	1,500	950,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	6.70E-02	2.19E-02	2.86E-03
PILE6	Aggregate Limestone Pile (Drop onto pile)	1,500	4,160,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	2.93E-01	9.61E-02	1.25E-02
PILE7	Middle Grade Limestone Pile (Drop onto pile)	1,500	950,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	6.70E-02	2.19E-02	2.86E-03
PILE8	High Calibur Limestone Pile (Drop onto pile)	1,500	950,000	95.3%	95.8%	2.12E-01	6.93E-02	9.04E-03	6.70E-02	2.19E-02	2.86E-03
BC-905	Belt Conveyor ²	800	4,160,000	100.0%	100.0%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BC-906	Belt Conveyor ²	800	4,160,000	100.0%	100.0%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BC-3	Existing Belt Conveyor	500	950,000	95.3%	95.8%	7.05E-02	2.31E-02	3.01E-03	6.70E-02	2.19E-02	2.86E-03
SN-900	Screen	500	950,000	91.2%	91.5%	1.10E+00	3.70E-01	1.38E-01	1.05E+00	3.51E-01	1.31E-01
LB-900	Limestone Surge Bin	500	950,000	0.0%	0.0%	3.78E-01	1.79E-01	2.71E-02	3.60E-01	1.70E-01	2.58E-02
RC-110	Roller Crusher	500	950,000	77.8%	77.8%	5.99E-01	2.66E-01	9.95E-02	5.69E-01	2.53E-01	9.45E-02
BC-9	Existing Belt Conveyor	400	950,000	95.3%	95.8%	5.64E-02	1.85E-02	2.41E-03	6.70E-02	2.19E-02	2.86E-03
SN-120	Screen	400	950,000	91.2%	91.5%	8.80E-01	2.96E-01	1.10E-01	1.05E+00	3.51E-01	1.31E-01
BC-130	Existing Belt Conveyor	80	950,000	95.3%	95.8%	1.13E-02	3.70E-03	4.82E-04	6.70E-02	2.19E-02	2.86E-03
BC-900	Belt Conveyor 900	75	350,000	95.3%	95.8%	1.06E-02	3.47E-03	4.52E-04	2.47E-02	8.09E-03	1.05E-03
BC-129	Belt Conveyor 129	75	350,000	95.3%	95.8%	1.06E-02	3.47E-03	4.52E-04	2.47E-02	8.09E-03	1.05E-03
PILE2	Limestone Fines Pile (Drop onto pile)	75	350,000	95.3%	95.8%	1.06E-02	3.47E-03	4.52E-04	2.47E-02	8.09E-03	1.05E-03
BC-901	Belt Conveyor ²	300	350,000	100.0%	100.0%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BC-200	Belt Conveyor	400	600,000	95.3%	95.8%	5.64E-02	1.85E-02	2.41E-03	4.23E-02	1.39E-02	1.81E-03
SN-210	Screen	400	600,000	91.2%	91.5%	8.80E-01	2.96E-01	1.10E-01	6.60E-01	2.22E-01	8.28E-02
BC-220	Stock Out (Tunnel) Conveyor	240	300,000	95.3%	95.8%	3.38E-02	1.11E-02	1.45E-03	2.12E-02	6.93E-03	9.04E-04
BC-230	Stock Out (Tunnel) Conveyor	160	300,000	95.3%	95.8%	2.26E-02	7.39E-03	9.64E-04	2.12E-02	6.93E-03	9.04E-04
PILE3	Limestone Pile (Drop onto pile)	240	300,000	95.3%	95.8%	3.38E-02	1.11E-02	1.45E-03	2.12E-02	6.93E-03	9.04E-04
PILE4	Limestone Pile (Drop onto pile)	160	300,000	95.3%	95.8%	2.26E-02	7.39E-03	9.64E-04	2.12E-02	6.93E-03	9.04E-04
BC-320	Belt Conveyor ²	150	600,000	100.0%	100.0%	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BC-327	Belt Conveyor	300	600,000	95.3%	95.8%	4.23E-02	1.39E-02	1.81E-03	4.23E-02	1.39E-02	1.81E-03
PILE5	Limestone Fines Pile (Drop onto pile)	100	60,000	95.3%	95.8%	1.41E-02	4.62E-03	6.03E-04	4.23E-03	1.39E-03	1.81E-04
SK-350	Skip Hoist	200	600,000	95.3%	95.8%	2.82E-02	9.24E-03	1.21E-03	4.23E-02	1.39E-02	1.81E-03
SK-360	Skip Hoist	200	600,000	95.3%	95.8%	2.82E-02	9.24E-03	1.21E-03	4.23E-02	1.39E-02	1.81E-03
NA	Wet Drilling and Truck Loading	300	600,000	0.0%	0.0%	5.40E-02	5.40E-02	5.40E-02	5.40E-02	5.40E-02	5.40E-02
Total						10.38	4.40	0.93	6.40	2.53	0.67

¹ Existing units are italicized.² Unit is located underground with no potential emissions to the atmosphere from the drop point.

Table B.6-3. Limestone Pile Wind Erosion Emissions

Source ID	Description	Pile Size (acres)	Silt Content ² (%)	Days w/ precip > 0.01" ³ (days/yr)	wind speed > 12 mph ⁴ (%)	PM Emission Factor ¹ (lb/acre/day)	PM ₁₀ /PM Ratio ⁵	PM _{2.5} /PM Ratio ⁵	PM Emissions (lb/hr)	PM ₁₀ Emissions (lb/hr)	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy)	PM ₁₀ Emissions (tpy)	PM _{2.5} Emissions (tpy)
PILE2	Limestone Fines Pile	0.09	3.9	130	17.8	5.245	0.5	0.075	1.93E-02	9.65E-03	1.45E-03	8.46E-02	4.23E-02	6.34E-03
PILE3	Limestone Pile	0.35	3.9	130	17.8	5.245	0.5	0.075	7.72E-02	3.86E-02	5.79E-03	3.38E-01	1.69E-01	2.54E-02
PILE4	Limestone Pile	0.35	3.9	130	17.8	5.245	0.5	0.075	7.72E-02	3.86E-02	5.79E-03	3.38E-01	1.69E-01	2.54E-02
PILE5	Limestone Reject Pile	0.03	3.9	130	17.8	5.245	0.5	0.075	6.30E-03	3.15E-03	4.73E-04	2.76E-02	1.38E-02	2.07E-03
PILE6	Aggregate Limestone Pile	0.35	3.9	130	17.8	5.245	0.5	0.075	7.72E-02	3.86E-02	5.79E-03	3.38E-01	1.69E-01	2.54E-02
PILE7	Middle Grade Limestone Pile	0.35	3.9	130	17.8	5.245	0.5	0.075	7.72E-02	3.86E-02	5.79E-03	3.38E-01	1.69E-01	2.54E-02
PILE8	High Calibur Limestone Pile	0.35	3.9	130	17.8	5.245	0.5	0.075	7.72E-02	3.86E-02	5.79E-03	3.38E-01	1.69E-01	2.54E-02
Total									4.12E-01	2.06E-01	3.09E-02	1.80E+00	9.02E-01	1.35E-01

¹ Air and Waste Management Association, Air Pollution Engineering Manual, page 136-7, equation 5.

PM = 1.7 x (s/1.5) x ((365-p)/235) x f/15 x p x a

PM PM/PM₁₀/PM_{2.5} emissions (lb/day)

s Average silt content of material (%)

p number of days with 0.01 inches of precipitation or more (days/yr)

f time wind speed is greater than 12 mph (%)

p particle size ratio

a pile size ratio (acres)

² Silt content represents mean values from AP-42 Table 13.2.4-1.

³ AP-42 Section 13.2.2, Figure 13.2.2-1

⁴ Data from Martinsburg, WV. Maximum calendar year value for the 2007 through 2011 calendar years.

⁵ PM₁₀ and PM_{2.5} ratios based on particle size multipliers found in AP-42 Section 13.2.5.

Table B.6-4. Limestone Handling Dust Collector Emissions

Source ID ²	Material Captured	Capacity (scfm)	Capacity (acfm)	PM Grain Loading Rate (gr/scf)	PM _{2.5} Grain Loading Rate (gr/scf)	Hours of Operation (hr/yr)	PM Emissions (lb/hr) ¹	PM ₁₀ Emissions (lb/hr) ¹	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy) ¹	PM ₁₀ Emissions (tpy) ¹	PM _{2.5} Emissions (tpy)
DC-906	Limestone Screen and Reject Bin Dust Collector	15,000	15,000	0.010	0.004	8,760	1.29	1.29	0.51	5.63	5.63	2.25
Total							1.29	1.29	0.51	5.63	5.63	2.25

Potential Material Transfer Factors

Table B.7-1. Coal/Coke Handling Emission Factors

Source ID	Description	Capacity (tons/hr)	Control Efficiency (%) ¹	PM Emission Factor ² (lb/ton)	PM ₁₀ Emission Factor ² (lb/ton)	PM _{2.5} Emission Factor ² (lb/ton)
PILE1	Enclosed Drop to Coke Pile	150	0%	8.47E-04	4.00E-04	6.06E-05
LOAD1	Coke Loader to 10 Cu. Yd. Dump Hopper	150	0%	8.47E-04	4.00E-04	6.06E-05
BC-2105	Belt Conveyor BC-2105	150			Routed to Dust Collector	
SB-COKE	Coke Storage Bin	150			Routed to Dust Collector	
WF-2109	Weigh Belt Feeder	6			Routed to Dust Collector	
CM-1	Bowl Mill	6			Routed to Dust Collector	
SC-635	Screw Conveyor	6			Routed to Dust Collector	

¹ Assumes no control² AP-42 Section 13.2.4.3 - Aggregate Handling and Storage Piles, Equation (1). (11/06).

$$E = k (0.0032)(U/5)^{1.3} / (M/2)^{1.4}$$

Where:

E = emission factor

k = particle size multiplier = 0.74 for PM, 0.35 for PM₁₀, and 0.053 for PM_{2.5}U = mean wind speed, 7.4 mph (from Dulles International Airport <http://wfn.cdnc.noaa.gov/oa/climate/online/ccd/avgwind.html>)

M = material moisture content (%), 6% coal/coke

Coal/Coke Emission Factor:

E (PM) = 8.47E-04

E (PM₁₀) = 4.00E-04

E (PM_{2.5}) = 6.06E-05

Table B.7-2. Coal/Coke Handling Emissions

Source ID	Description	Capacity (tons/hr)	Potential Throughput (tons/yr)	PM Emissions (lb/hr)	PM ₁₀ Emissions (lb/hr)	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy)	PM ₁₀ Emissions (tpy)	PM _{2.5} Emissions (tpy)
PILE1	Enclosed Drop to Coke Pile	150	52,560	1.27E-01	6.01E-02	9.10E-03	2.23E-02	1.05E-02	1.59E-03
LOAD1	Coke Loader to 10 Cu. Yd. Dump Hopper	150	52,560	1.27E-01	6.01E-02	9.10E-03	2.23E-02	1.05E-02	1.59E-03
Total				2.54E-01	1.20E-01	1.82E-02	4.45E-02	2.10E-02	3.19E-03

Table B.7-3. Coal/Coke Handling Dust Collector Emissions

Source ID	Description	Capacity (scfm)	Capacity (acfm)	PM Grain Loading Rate (gr/scf)	PM _{2.5} Grain Loading Rate (gr/scf)	Hours of Operation (hr/yr)	PM Emissions (lb/hr) ¹	PM ₁₀ Emissions (lb/hr) ¹	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy) ¹	PM ₁₀ Emissions (tpy) ¹	PM _{2.5} Emissions (tpy)
DC-2106	Coal/Coke Bin Dust Collector	4,000	4,000	0.010	0.004	8,760	0.34	0.34	0.14	1.50	1.50	0.60
DC-630	Coal/Coke Mill Dust Collector	8,252	9,500	0.010	0.004	8,760	0.71	0.71	0.28	3.10	3.10	1.24
DC-907	Dust Collector 8K1.BF01 Controls - Coke 8K1.CL01	4,227	4,227	0.010	0.004	8,760	0.36	0.36	0.14	1.59	1.59	0.63
Total							1.41	1.41	0.56	6.19	6.19	2.47

¹ Assumes all PM is PM₁₀.

Table B.7-4. Combustion Input Parameters

Heating Value of Natural Gas ¹	1,028	Btu/R ³
Heat Input Capacity of Heater	3.5	MMBtu/hr

¹ Heating value is from AP-42, 5th Edition, Table 1.4-1, footnote a (7/98).

Table B.7-5. Combustion Emissions

Pollutant	Natural Gas Emission Factor ¹ (lb/MMft ³)	Potential Emissions	
		lb/hr	tpy
Criteria			
SO ₂	0.6	2.04E-03	8.95E-03
NO _x ²	50	0.17	0.75
VOC	5.5	0.02	0.08
CO	84	0.29	1.25
HAP/TAP Emissions			
Benzene	2.10E-03	7.15E-06	3.13E-05
Dichlorobenzene	1.20E-03	4.09E-06	1.79E-05
Formaldehyde	7.50E-02	2.55E-04	1.12E-03
n-Hexane	1.80E+00	6.13E-03	2.68E-02
Naphthalene	6.10E-04	2.08E-06	9.10E-06
Selenium	2.40E-05	8.17E-08	3.58E-07
Toluene	3.40E-03	1.16E-05	5.07E-05
POM ³	8.82E-05	3.00E-07	1.32E-06
Arsenic	2.00E-04	6.81E-07	2.98E-06
Beryllium	1.20E-05	4.09E-08	1.79E-07
Cadmium	1.10E-03	3.75E-06	1.64E-05
Chromium	1.40E-03	4.77E-06	2.09E-05
Cobalt	8.40E-05	2.86E-07	1.25E-06
Lead	5.00E-04	1.70E-06	7.46E-06
Manganese	3.80E-04	1.29E-06	5.67E-06
Mercury	2.60E-04	8.85E-07	3.88E-06
Nickel	2.10E-03	7.15E-06	3.13E-05
Greenhouse Gases ^{4,5}			
CO ₂	120,161	409.11	1,791.89
CH ₄	2.27	7.72E-03	3.38E-02
N ₂ O	0.23	7.72E-04	3.38E-03
CO ₂ e		409.51	1,793.65

¹ Emission factors are from AP-42, 5th Edition, Section 1.4 (7/98).

² Assumes controlled Low NO_x burners for natural gas combustion from AP-42, Table 1.4-1.

³ Additive factor for all POM materials listed in AP-42 Section 1.4, Table 1.4-3

⁴ GHG emission factors are from 40 CFR 98 Subpart C Tables C-1 and C-2.

⁵ Global warming potential from 40 CFR 98 Subpart A Table A-1.

CO₂ 1
CH₄ 21
N₂O 310

Table B.7-6. Coal/Coke Pile Wind Erosion Emissions

Source ID	Description	Pile Size (acres)	Silt Content ² (%)	Days w/ precip > 0.01" ³ (days/yr)	Wind Speed > 12 mph ⁴ (%)	Emission Factor ¹ (lb/acre/day)	PM ₁₀ /PM Ratio ⁵	PM _{2.5} /PM Ratio ⁵	PM Emissions (lb/hr)	PM ₁₀ Emissions (lb/hr)	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy)	PM ₁₀ Emissions (tpy)	PM _{2.5} Emissions (tpy)
PILE1 ⁶	Coal/Coke Pile	0.01	2.2	130	17.8	2.959	0.5	0.075	3.23E-04	1.61E-04	2.42E-05	1.41E-03	7.07E-04	1.06E-04

¹ Air and Waste Management Association, Air Pollution Engineering Manual, page 136-7, equation 5.

PM = 1.7 x (s/1.5) x ((365-p)/235) x f/15 x p x a

PM PM/PM₁₀/PM_{2.5} emissions (lb/day)

s Average silt content of material (%)

p number of days with 0.01 inches of precipitation or more (days/yr)

f time wind speed is greater than 12 mph (%)

p particle size ratio

a pile size ratio (acres)

² Silt content represents mean value from AP-42 Table 13.2.4-1.

³ AP-42 Section 13.2.2, Figure 13.2.2-1

⁴ Data from Martinsburg, WV. Maximum calendar year value for the 2007 through 2011 calendar years.

⁵ PM₁₀ and PM_{2.5} ratios based on particle size multipliers found in AP-42 Section 13.2.5.

⁶ Coal/coke pile is partially enclosed by a three-sided shed. Control efficiency of 70% for partial enclosure obtained from Air Pollution Engineering manual.

Table B.8-1 Lime Handling Baghouses

Source ID ²	Material Captured	Capacity (scfm)	Capacity (acfm)	PM Grain Loading Rate (gr/scf)	PM _{2.5} Grain Loading Rate (gr/scf)	Hours of Operation (hr/yr)	PM Emissions (lb/hr) ¹	PM ₁₀ Emissions (lb/hr) ¹	PM _{2.5} Emissions (lb/hr)	PM Emissions (tpy) ¹	PM ₁₀ Emissions (tpy) ¹	PM _{2.5} Emissions (tpy)
DC-410	Kiln 2 Lime Handling Dust Collector	10,000	11,512	0.010	0.004	8,760	0.86	0.86	0.34	3.75	3.75	1.50
DC-555	New Lime Handling Dust Collector 555	5,000	5,756	0.010	0.004	8,760	0.43	0.43	0.17	1.88	1.88	0.75
DC-535	Reject Lime Dust Collector	4,000	4,605	0.010	0.004	8,760	0.34	0.34	0.14	1.50	1.50	0.60
DC-900	Loadout Bin LB-901 Dust Collector	2,000	2,000	0.010	0.004	8,760	0.17	0.17	0.07	0.75	0.75	0.30
DC-520	Lime Roll Crusher Dust Collector	8,000	9,210	0.010	0.004	8,760	0.69	0.69	0.27	3.00	3.00	1.20
DC-2533	<i>Lime Product Dust Collector</i>	7,000	7,000	0.010	0.004	8,760	0.60	0.60	0.24	2.63	2.63	1.05
DC-2532	<i>Lime Product Dust Collector</i>	2,500	2,500	0.010	0.004	8,760	0.21	0.21	0.09	0.94	0.94	0.38
DC-2525	<i>Lime Product Dust Collector</i>	2,375	2,375	0.010	0.004	8,760	0.20	0.20	0.08	0.89	0.89	0.36
DC-2341	<i>Lime Product Dust Collector</i>	4,000	4,000	0.010	0.004	8,760	0.34	0.34	0.14	1.50	1.50	0.60
DC-1	<i>Lime Product Dust Collector</i>	15,000	15,000	0.010	0.004	8,760	1.29	1.29	0.51	5.63	5.63	2.25
DC-2	<i>Lime Product Dust Collector</i>	15,000	15,000	0.010	0.004	8,760	1.29	1.29	0.51	5.63	5.63	2.25
Total							6.42	6.42	2.57	28.11	28.11	11.24

¹ Assumes all PM is PM₁₀.² Existing units are italicized.PM_{2.5} grain loading calculated based on data obtained from EPA PM Calculator (<http://www.epa.gov/ttn/chief/eiinformation.html>):*Lime Manufacturing - Product Transfer and Conveying [SCC 30501615] with fabric filter control.*PM₁₀ = 0.57%PM_{2.5} = 0.30%Assume PM_{2.5} = 50% PM₁₀

Road Emissions

Table B.9-1. Route and Truck Information

Route	Route Length (miles)	Baseline Actual Annual No. of Vehicles	Potential Annual No. of Vehicles ¹
Paved Roads - Product	0.25	4,430	13,652
Paved Roads - Fuel	0.25	1,417	1,784
Baseline Unpaved Roads - Raw Material	2	4,852	
Post Project Unpaved Roads - Raw Material	1.1		5,652
Paved Roads - Product (new)	0.5	4,430	13,652
Paved Roads - Fuel (new)	0.5	1,417	1,784

¹ Potential number of vehicles calculated by dividing the potential throughput by the load per vehicle.

Table B.9-2. Particulate Emissions from Road Emissions

Emission Factor ^{1,2}				Baseline Actual							Potential Emissions ⁴						
Road Segment	PM	(lb/VMT)		Distance Traveled (VMT/yr)	PM Emissions (tpy)	PM ₁₀ Emissions (tpy)	PM _{2.5} Emissions (tpy)	PM Emissions (lb/hr)	PM ₁₀ Emissions (lb/hr)	PM _{2.5} Emissions (lb/hr)	Distance Traveled (VMT/yr)	PM Emissions (tpy)	PM ₁₀ Emissions (tpy)	PM _{2.5} Emissions (tpy)	PM Emissions (lb/hr)	PM ₁₀ Emissions (lb/hr)	PM _{2.5} Emissions (lb/hr)
		PM ₁₀	PM _{2.5}														
Paved Roads - Fuel/Product	2.00	0.40	0.10	1,461.71	1.46	0.29	0.07	0.50	0.10	0.02	3,858.94	0.77	0.15	0.04	0.18	0.04	0.01
Unpaved Roads - Stone (old trucks)	7.82	2.22	0.22	9,704.24	37.94	10.77	1.07	12.99	3.69	0.37							
Unpaved Roads - Stone (new trucks)	10.06	2.86	0.29								6,217.20	6.25	1.78	0.18	1.43	0.41	0.04
Unpaved Roads - Fuel/Product (old)	6.87	1.95	0.20	2,923.41	10.04	2.85	0.29	3.44	0.98	0.10							
Paved Roads - Fuel/Product (new)	2.00	0.40	0.10								7,717.88	1.54	0.31	0.08	0.35	0.07	0.02
Total					49.45	13.91	1.43					8.57	2.24	0.29	1.96	0.51	0.07

¹ Paved route emission factor is based on Equation 2 of AP-42 Section 13.2.1 (January 2011):

$$E = [k (sL)^{0.91} \times (W)^{1.02}] (1 - P/4N)$$

E = size specific emission factor (lb/VMT)

k = 0.011 PM particle size multiplier for particle size range and units of interest, AP-42, Section 13.2.1, Table 13.2.1-1.

0.0022 PM₁₀

0.00054 PM_{2.5}

sL = 8.2 road surface silt loading (g/m²), taken from AP-42, Section 13.2.1, Table 13.2.1-3 for Quarries

W = 27.5 mean vehicle weight (tons)

P = 130 number of days in the averaging period with at least 0.254 mm (0.01 in) of precipitation, AP-42 Section 13.2.1, Figure 13.2.1-2.

N = 365 number of days in the averaging period (e.g., 365 for annual)

² Unpaved route emission factor is based on Equations 1a and 2 of AP-42 Section 13.2.2 (November 2006):

Equations 1a and 2 (combined):

$$E = [k (s/12)^a \times (W/3)^b] [(365 - P)/365]$$

E = size specific emission factor (lb/VMT)

s = 8.3 surface material silt content (%), taken from AP-42, Section 13.2.2, Table 13.2.2-1 for Stone Quarry Haul Road.

W = 40 old mean vehicle weight (tons) for stone

W = 70 new mean vehicle weight (tons) for stone

W = 30 mean vehicle weight (tons) for product/fuel

k = 4.90 PM particle size multiplier, AP-42 Section 13.2.2, Table 13.2.2-2.

1.50 PM₁₀

0.15 PM_{2.5}

a = 0.70 PM empirical constant, AP-42 Section 13.2.2, Table 13.2.2-2.

0.90 PM₁₀/PM_{2.5}

b = 0.45 empirical constant, AP-42 Section 13.2.2, Table 13.2.2-2.

P = 130 number of days in a year with at least 0.254 mm (0.01 in) of precipitation, AP-42 Section 13.2.2, Figure 13.2.2-1

³ Calculated from annual emissions and assuming truck traffic 365 days per year and 16 hours per day.

⁴ Assumes a PM/PM₁₀/PM_{2.5} control efficiency of 80% from watering roads. No control efficiency applied to baseline actual emission calculations since the roads were not watered during the baseline period.

Table B.10-1. Engine Input Parameters

Process Parameter	Units	
Run Time	500	hours/year
New Emergency Engine #2 Rating	200	hp
New Emergency Engine #2 Rating	150	kW
Break-Specific Fuel Consumption ¹	7,000	Btu/hp-hr

¹ AP-42, Fifth Edition, Section 3.3, Gasoline & Diesel Industrial Engines (10/96), Table 3.3-1 footnote c.

Table B.10-2. Emergency Engine Emissions Summary

Pollutant	Emission Factor ^{2,3}	Units	Engine #2 Emissions ⁵		
			lbs/hr	lbs/yr	tons/yr
PM ₁₀	0.20	g/kW-hr	0.07	33.07	1.65E-02
PM _{2.5}	0.20	g/kW-hr	0.07	33.07	1.65E-02
SO _x	2.05E-03	lb/hp-hr	0.41	205.00	1.03E-01
NO _x	4.0	g/kW-hr	1.32	661.39	0.33
NMHC	4.0	g/kW-hr	1.32	661.39	0.33
CO	3.5	g/kW-hr	1.16	578.72	0.29
CO ₂ ⁴	163.05	lb/MMBtu	228.27	114,136.55	57.07
CH ₄ ⁴	6.61E-03	lb/MMBtu	0.01	4.63	2.31E-03
N ₂ O ⁴	1.32E-03	lb/MMBtu	1.85E-03	0.93	4.63E-04
CO _{2e}			229.04	114,520.81	57.26
Benzene	9.33E-04	lb/MMBtu	1.31E-03	0.65	3.27E-04
Toluene	4.09E-04	lb/MMBtu	5.73E-04	0.29	1.43E-04
Xylene	2.85E-04	lb/MMBtu	3.99E-04	0.20	9.98E-05
Propylene	2.58E-03	lb/MMBtu	3.61E-03	1.81	9.03E-04
1,3 Butadiene	3.91E-05	lb/MMBtu	5.47E-05	0.03	1.37E-05
Formaldehyde	1.18E-03	lb/MMBtu	1.65E-03	0.83	4.13E-04
Acetaldehyde	7.67E-04	lb/MMBtu	1.07E-03	0.54	2.68E-04
Acrolein	9.25E-05	lb/MMBtu	1.30E-04	0.06	3.24E-05
Benzo(a)pyrene	1.88E-07	lb/MMBtu	2.63E-07	0.00	6.58E-08
PAH	1.68E-04	lb/MMBtu	2.35E-04	0.12	5.88E-05

² Unless otherwise noted, emission factors taken from AP-42, Fifth Edition, Section 3.3, Gasoline & Diesel Industrial Engines (10/96), Tables 3.3-1 and 3.3-2. All PM assumed to be less than 1 micron per footnote b of Table 3.3-1.

³ Emission factors taken from NSPS Subpart IIII. Emission limit for NO_x and NMHC is combined for Tier 3 engines. Emissions are calculated assuming the combined emission factor is for each pollutant.

⁴ Emission factors taken from Tables C-1 and C-2 to Subpart C of Part 98. Global Warming Potentials taken from Table A-1 of Part 98.

⁵ Engines #2 is a certified Tier 3 engine.